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VOL. LXXV

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TRANSACTIONS

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VOL. 75. 1927.

A STUDY OF BUTTERFLY MIGRATION IN SOUTH INDIA AND CEYLON, BASED LARGELY ON RECORDS BY MESSRS. J. EVERSHED, E. E. GREEN, J. C. F. FRYER AND W. ORMISTON

By C. B. WILLIAMS, M.A.

(Chief Entomologist, Ministry of Agriculture, Cairo, Egypt.)

[Read June 2nd, 1926.]

WITH TEN TEXT-FIGURES.

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I. Introduction.

I have been for some years collecting published and unpublished records of insect migration in different parts of the world and among these were many relating to the Island of Ceylon. Within the past year I have, however, been unusually fortunate in having placed at my disposal by the observers three important sets of observations on the migration, flighting or unidirectional flights of butterflies in Ceylon and the adjacent part of India. As the combined records for this area are now probably greater than those for almost any other part of the world, it appeared to me to be a good opportunity for summarising the known information and for seeing what, if any, generalisations can be made and what special lines are indicated for future observations and research. The present paper is an attempt in this direction.

Sources of Information.

Unidirectional flights of butterflies in large or small numbers appear to have been for long a source of wonder to the inhabitants of Ceylon, and the natives have even evolved a superstition as to their goal and have thought the insects to be on a pilgrimage to Adam's Peak or elsewhere.

The first printed record of their occurrence appears to be a footnote in J. E. Tennent's account of Ceylon published in 1859 (see List of References, p. 32). This note was repeated in the same writer's *Natural History of Ceylon* in 1861. Since this date numerous short notes have appeared, but no summary has been made except that by Manders (1904), who gave in a map general conclusions drawn from his own observations, without, however, giving in detail any of the observations on which these conclusions were based. His results will be discussed again later.

Apart from the published records which are gratefully acknowledged by the giving of the references, the following important sets of records are here given for the first time, and the observers are most sincerely thanked for their disinterestedness in giving me full liberty to utilise their notes in any way.

(1) Records made at Kodaikanal, S. India, by Mr. J. Evershed, F.R.S., Director of the Observatory, at various dates between the years 1907 and 1921. As these are the only records for this area they have been treated as a separate section.

(2) Records made in Ceylon by Mr. E. E. Green, formerly Government Entomologist, between the years 1899 and 1912.

(3) Records made in Ceylon by Mr. J. C. F. Fryer, between March 1911 and September 1912.

(4) A number of general notes kindly supplied by Mr. W. Ormiston, who has resided in the Island of Ceylon for many years and is a recognised authority on the butterflies of the island.

(5) A few replies to a circular issued in 1916 by the Natural History Society of Ceylon asking for information about migratory flights. These have been placed at my disposal by the secretary of the Society through the kind intervention of Mr. E. E. Green.

I am also greatly indebted to Mr. W. E. Browne of the Desert Survey, Cairo, for redrawing all the maps and diagrams illustrating this paper.

General Notes on Environment.

The area under consideration is entirely within the tropics between latitude 6° N. and 10·30° N., and longitude 77° E. and 82° E. The temperature is moder-

ately uniform, and the seasons depend on changes from wet to dry rather than upon the hot to cold changes that are found in temperate regions.

There are considerable local variations which will be dealt with in more

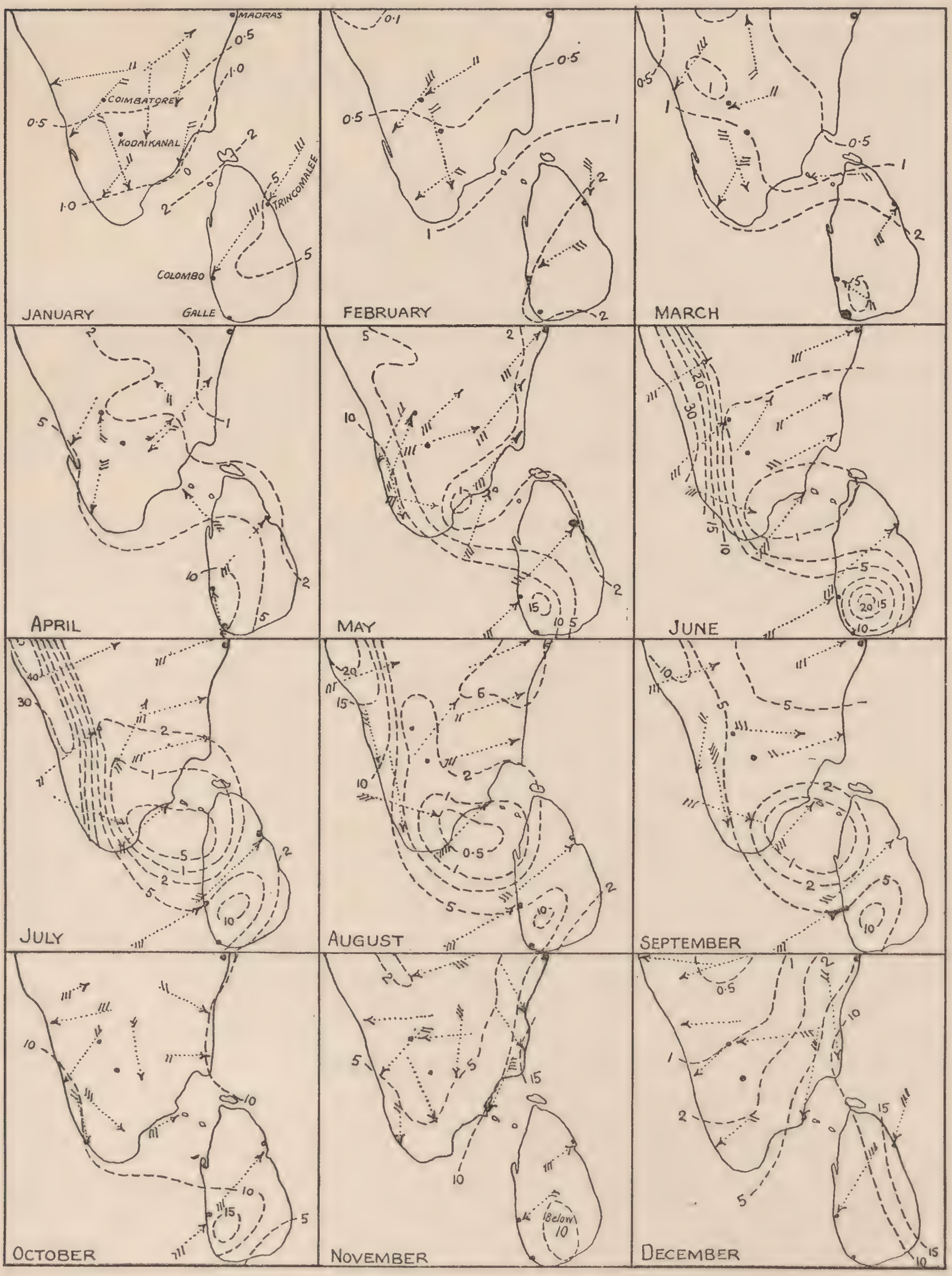

FIG. 1.—Monthly average rainfall and prevailing winds in Ceylon and South India.

detail later, but in the main the changes are determined by the two monsoon winds, the N.E. monsoon lasting more or less from December to March, and the S.W. monsoon which lasts more or less from May to October.

Kodaikanal, being at a high altitude, is much cooler than the Ceylon localities discussed and the influence of the winds is less definite.

The main monthly changes in rainfall and wind direction, constancy and force are shown in Fig. 2, which is combined from two maps given in the "Climatological Atlas of India," published by the Indian Meteorological Office in 1906.

The length of the arrow indicates constancy, and the number of tails the average force of the wind. The rainfall figures are in inches.

II. S. India: Kodaikanal.

Special Notes on Environment.

Before discussing any questions of local topography or climate it must be understood that none of the migrations observed at Kodaikanal by Mr. Evershed are considered as having in any way originated in that locality. It is merely a post en route where fortunately there was an observer. Thus the environmental characters are of less importance, though they should be observed. If the climatic or environmental factors have any influence on the origin of the flights, the data should be sought further north or further south in a warmer climate at less elevation.

The Observatory of Kodaikanal, where nearly all the observations were made, is at an altitude of 2343 metres (7688 feet) on the Pulney Hills, which form a spur of the southern part of the Western Ghauts extending eastwards for about 40 miles.

The following are some notes on the district kindly supplied by Mr. Evershed.

"On the north lies the plain, about 80 miles wide, which separates the Pulneys from the Nilgiris. To the south and east are also stretches of level plain but less extensive, being broken by more or less detached mountain masses and smaller hills. The total width of the hills from north to south is not more than about 15 to 20 miles at the base and in the upland region one may get views over the plains northwards or southwards in a walk of four or five miles only. The slopes are very steep and precipitous, especially along the southern side, which consists of a series of formidable cliffs, in some places perhaps 2000 feet high. The upland region at the top of these cliffs consists of rolling grassy downs intersected by numerous streams leading into small rivers, which descend in imposing waterfalls to the plains on either side.

"The flora of the upland regions is of a temperate character, although the 'sholas' or woods which lie in the folds of the hills bordering the streams contain trees and shrubs which are largely of tropical genera.

"There is usually a well-marked dry period in February, but later in the year local thunderstorms develop in the afternoons and yield heavy falls of rain. These storms cease entirely when the monsoon current sets in early in June. Then follows cloudy weather with a strong wind from the west or north-west, continuing with occasional breaks throughout July and August, and in some years September also. Fine rain and mist is prevalent during this period. In the autumn cyclonic storms in the Bay of Bengal give rise to very heavy rain in the Pulneys.

"Excepting for strong winds from the west between June and August, winds are light and variable. The average is about 11 miles per hour and mainly from the north-east, in the months November to June. Gales are unknown."

The mean monthly temperature and rainfall are as follows, and are indicated graphically in Fig. 2. The figures are from the Annual Report of Kodaikanal and Madras Observatories for 1920, p. 16.

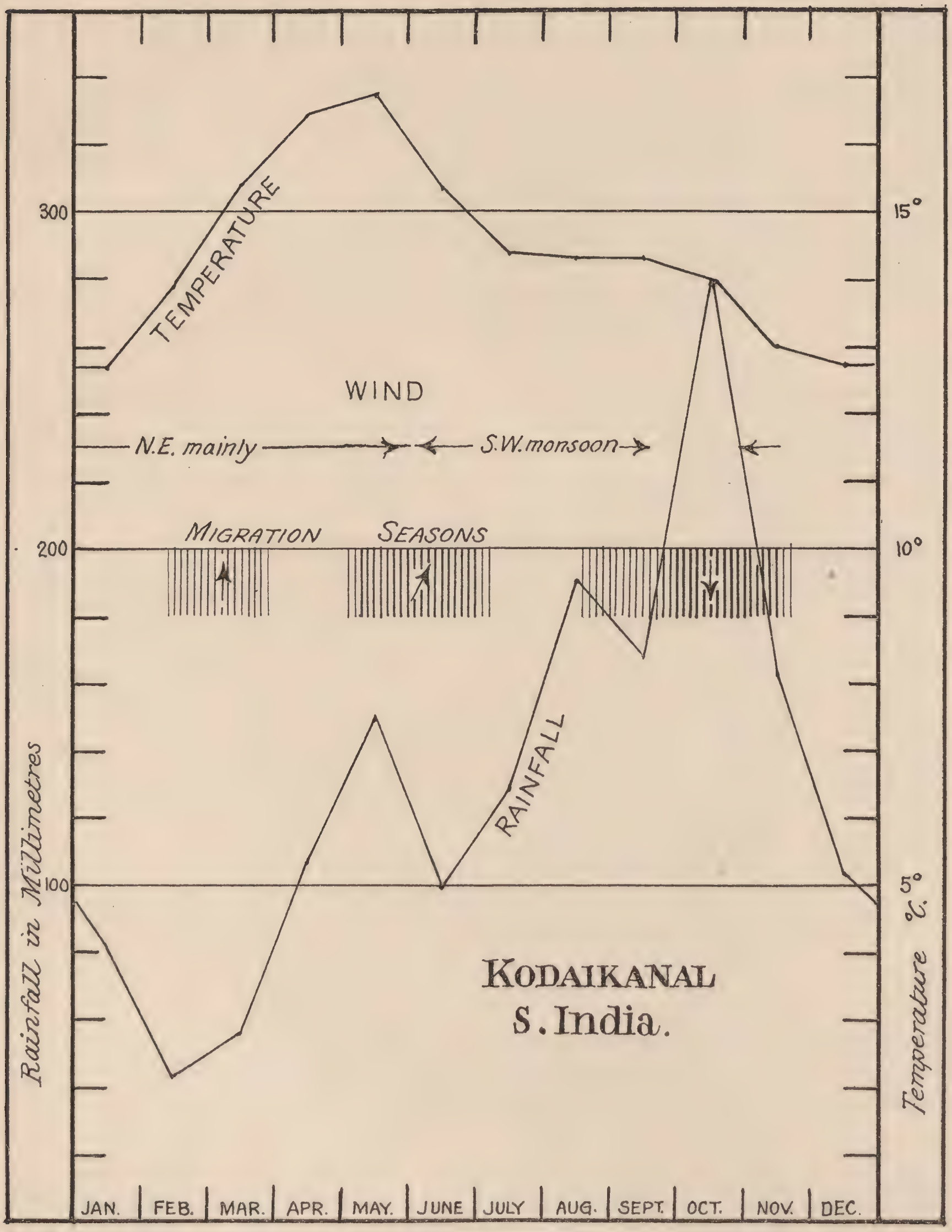

FIG. 2.—Diagram showing climatic features at Kodaikanal.

From Kodaikanal Observatory, Means for 20 years to December, 1920.

Temperature °C. ...	12·4	13·2	14·8	15·9	16·1	14·7	13·9	13·9	14·0	13·5	12·5	12·2
Rain mm.	73	35	52	109	151	102	126	178	178	252	198	117

Summary of Records.

Observations made by J. Evershed at Kodaikanal, S. India.

Date.	Species.	Direction.	Notes.
1907.			
Feb.–Mar.	*Catopsilia pyranthe.*	North.	
1908.			
May 16 to begin. July.	*Catopsilia crocale.*	N. and N. by E.	S.W. monsoon set in on June 11.
Oct. 7–21.	Dragonflies, *Papilio demoleus* (enormous numbers), *H. bolina*, *P. hector*, *Catopsilia crocale*, *C. ? catilla*, *D. plexippus*, *limniace* and *septentrionis*, *Junonia hierta*, *J. orithya*, *J. lemonias*, *Atella phalantha.*	South.	Monsoon set in on Oct. 22. Catopsilias in 2nd week.
1909.			
Mar. 28.	*Euploea core*, *C. crocale*, *C. pyranthe.*	To S.E.	Wind from S.E.
June 13–15.	*C. crocale*, *pyranthe*, *P. demoleus* and others.	E., E. by S. and N.E.	
Oct. 3–25.	*P. demoleus*, *E. ariadne*, *A. phalantha*, *J. orithya*, *J. hierta*, *J. lemonias*, *H. bolina*, *C. pyranthe*, a few *P. hector* and *Parnara mathias* (great many).	S., S. by W., S.S.W. and S.W.	
1910.	No records.		
1911.			
Jan. 4–28 and Feb. 19.	*Polyommatus boeticus.*	S.E.	Wind from E.
Jan. 28–30.	*Appias albina.*	S.E. by S.	
Feb. 12 and 19.	Catopsilias.	W. and N.W.	
Mar. 12.	*Appias* sp.	N.E.	
Mar. 19.	*P. boeticus* (many).	To S.E.	Wind strong S.E.
	Appias, males (several).	N.E.	
	Catopsilias (a few).	N.	
1912.			
Mar. 23, 24, 25, and 28.	*Catopsilia pyranthe* only, in numbers.	N. by E.	None before this.
May 19 (about).	*Catopsilia catilla.*	E., E.S.E. and S.E.	Two distinct streams at 10–10.30 a.m.
	Appias and a few Catopsilias.	N. and N. by E.	
May 20–29.	*Catopsilia catilla* (pale form); on 28th all *crocale.*	Mostly E. to S.E., also some N. to N.E.	Apparently two streams.
July 31.	Large Catopsilias.	Various, but mostly N. to E.	Nothing seen during monsoon weather till this date.
Sept. 11.	*C. pyranthe* (several), *P. hector* (only one).	South.	
Sept. 21.	*D. limniace* (5 or 6).	S. or S. by E.	
Sept. 15–29.	*H. bolina* (several each day).	Toward S.W. to S.E.	
Oct. 6.	*H. bolina* (large numbers of both sexes).	S. and S.S.W.	
Oct. 9	*C. pyranthe* (large numbers).	S. and S.W.	
Oct. 13.	*C. pyranthe* (large numbers).	More or less S.	
Oct. 16.	*C. pyranthe* (snow-storm).		
Oct. 16.	*P. demoleus* (large numbers), *A. phalantha*, *H. missipus* (considerable number of females, a few males), *H. bolina*, *D. plexippus* (1), *D. limniace* (1), *J. hierta* (a few), *J. lemonias* (1), *C. florella* ? (a few).	S. (more or less).	
Oct. 30.	*P. demoleus* (large numbers), *C. pyranthe* (snow-storm), *H. bolina* (a few).	S. (more or less).	
Oct. 31.	*C. pyranthe*, *P. demoleus*, *Atella* (great many of all).	S. (more or less).	
Nov. 3–4.	*C. pyranthe* (small number).	N.E.	
Nov. 5–6.	*C. catilla* (considerable numbers).	S.W. and W.S.W.	
	P. demoleus (a few), *H. bolina* (a few), *Junonia* sp. (several).	S.W. (more or less).	
Nov. 10.	Hebomoias (many), Catopsilias (*catilla* chiefly).	South.	
Nov. 14–22.	*P. demoleus* and Catopsilias.	South.	
1913.			
Mar. 2–9.	Catopsilias and *Appias* (a few only).	North.	
May 18–31. June 1.	*Catopsilia crocale*, *catilla* or *florella* (not *pyranthe*).	N.E. and E.N.E.	First marked migration of year (June 1, " Bright day with a monsoon threatening ").
1914.			
Nov. 11.	*Catopsilia catilla* (considerable numbers), also *E. ariadne*, Junonias, *Atella phalantha.*	W. and W. by S.	Fine day after long wet period.
1915–20.	No records.		
1921.			
Aug. 21.	*C. pyranthe* (many), also *C. crocale*, *P. demoleus* (many), *A. phalantha* (many), *D. aglea* (a few), *J. hierta* (a few).	South.	

Notes on Migrations.

The following more detailed notes on the above records appear worthy of complete record.

1908, 15th *June.* "Fine sunny day, but strong monsoon wind, W. by N., after four dull rather rainy days since monsoon set in on 11th. At 12 noon *C. crocale* was observed flying in two separate streams, one to E. or E.S.E., the other to N. or N. by E. in considerable numbers, the former flying with the wind."

1908, *October.* "It was noticed that the butterflies on reaching the fog clouds near the Ghaut on the south side were turned back by it, but the instinct for a southerly direction was evidently operating even with contrary winds and a cloudy sky. Fog, however, baffled them and they had to retreat before it, returning, however, again and again right up to the edge of the wall of fog."

Records according to Years.

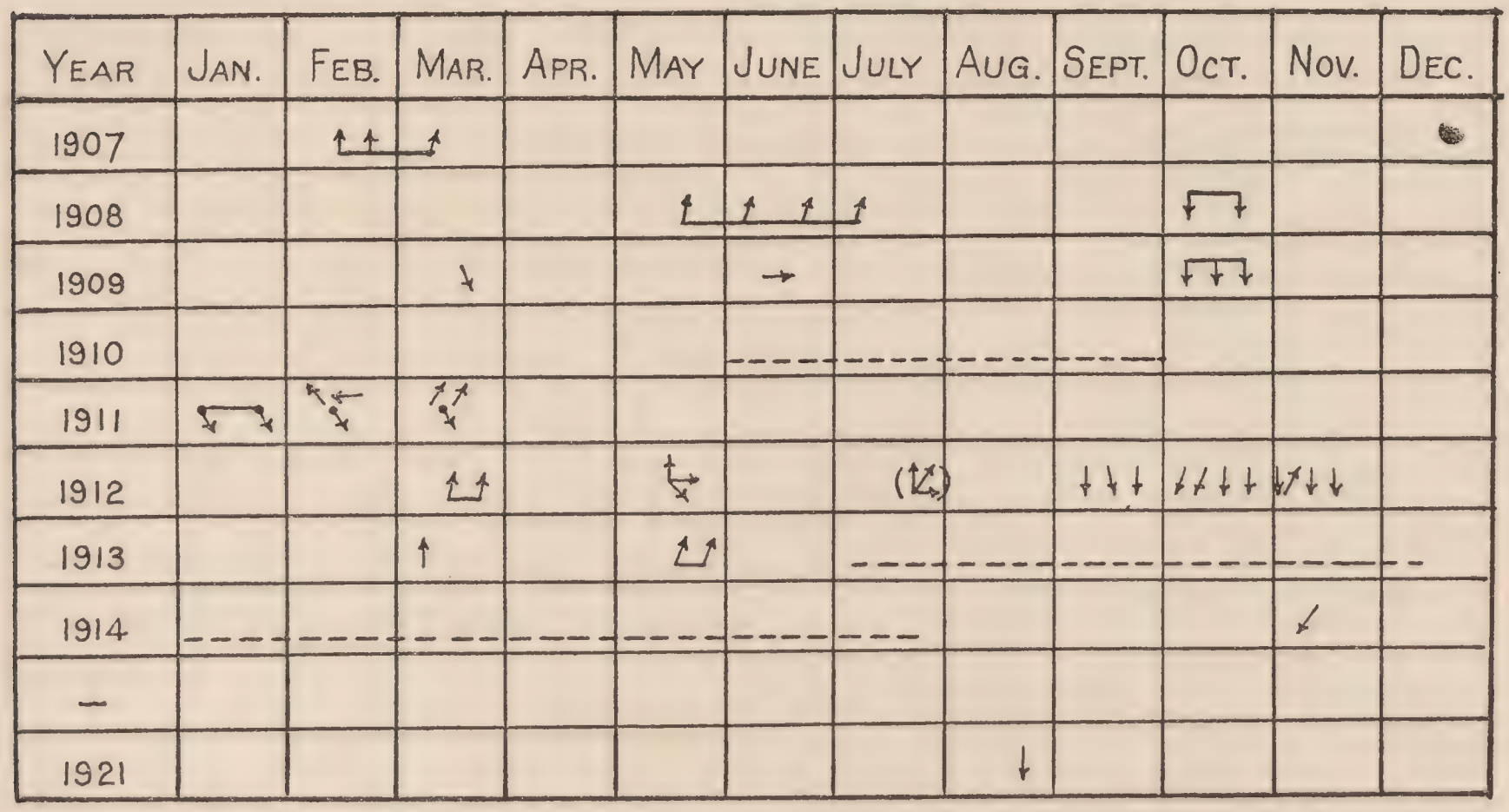

Fig. 3.—Records of migration at Kodaikanal showing year, month, and direction. (Dotted line shows absence of observer.)

"On 15th October [1908] thousands of Papilios were observed crossing the road between Peryakulam and Ammayanayakanur in the plains south of the Pulni Hills and tens of thousands of dragonflies going in the same direction, viz. north to south" (Dr. R. Todd).

1911, *Jan.* 11*th.* "A constant stream of *P. boetica* was observed flying S.E. in our garden in front of the house from 1 p.m. to 3.30, only interrupted when the sun was obscured by cloud. They seemed to be unmixed with any other species. . . . There are both males and females. The migration began about a week ago. They stop on the flowers and to play with one another, but on the whole press forward in spite of a strong east wind."

Jan. 13*th.* "E.N.E. wind too strong for the blues (25 miles an hour). . . . They are fine specimens in perfect condition."

Jan. 28*th.* "Blues still running strong, having only stopped during two wet days. A remarkable flight of *Appias albina* first noticed this day, approxi-

Records according to Species.

Species	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Papilionidæ												
Papilio demoleus						↓↑		↓		↓↓↑↓↓	↓↓	
» *hector*									↓	↓↓↓		
Pieridæ												
Catopsilia pyranthe		↑	↓↑↑			↓↑		↓	↓	↓↓↓↓↓	↑	
» *crocale*			↓		↓↑	↑↓↑	↑	↓		↓↓		
» *catilla*					↓					↓↓	↓↓	
» *(florella?)*										↓		
» *spp.*		←↖	↑↑		↑↑↑						↓↓	
Appias (usually albina)	↓	↗	↑↑		↑		↳					
Hebomoia (glaucippe)											↓	
Danaidæ												
Danais aglioe								↓				
» *plexippus*										↓↑↓		
» *limniacœ*									↓	↓↑↓		
» *septentrionalis*										↓↓		
Euploea core			↓									
Nymphalidæ												
Hypolimnas bolina									↓↓	↓↓↓↓↓	↓	
» *misippus*										↓		
Junonia hierta								↓		↓↓		
» *orythya*										↓↓↓		
» *lemonias*										↓↓		
» *sp*											↓↓	
Atella phalanta								↓		↓↓		
» *ariadne*										↓↓	↓	
» *spp.*										↓		
Lycænidæ											↓↓	
Polyommatus boeticus	↓↓	↓	↓									
Hesperidæ												
Parnasa mathias										↓		
Dragon Flies										↓↓		

Fig. 4.—Records of migration at Kodaikanal showing species, month, and direction.

mately in the same direction as the blues, viz. S.E. by S. Both sexes in fine condition. It was curious to note the nearly opposite direction of flight of a few sporadic Catopsilias, mostly *pyranthe*."

1912, *May* 18*th*, " and several days before. Catopsilias going E., E.S.E. and S.E. *Appias* and a few Catopsilias going N. and N. by E. Two distinct streams."

1912. " The great flight in Madras on the 3rd November was going, according to Patten, in a northerly direction, and were mostly white and yellow species (Catopsilias)."

It is interesting to note that this is exactly opposite to the normal direction of flight at Kodaikanal at this time of the year.

General Discussion on the Records at Kodaikanal.

Mr. Evershed in a letter writes : " There is scarcely a sunny day in the year when individual butterflies may not be seen flying in some definite direction. By standing in the track of an individual and observing the compass bearing as it recedes in the distance I have been much impressed by the accuracy with which different individuals pursue parallel courses in a fixed azimuth. If obstacles are encountered, such as trees or a house, the insects will go over rather than round them and the same habit applies by the great obstacle presented by the Pulney Hills. The butterflies, travelling over the plains could easily avoid the hills by going a little to the east, but this would violate the azimuth instinct by several degrees, and so they prefer to maintain a direct course, rising some six thousand feet up great precipices and into a cold climate, then crossing the hills and descending to the plains on the other side. How far they travel I have unfortunately been unable to ascertain, but simultaneous observations in the hills and on the plains that are in the neighbourhood indicate identical directions of flight."

" The butterflies fly always within a yard or two of the ground. They do not take short cuts through the air across valleys, and they will penetrate woods if the undergrowth is not too thick, maintaining undisturbed the fixed direction of flight. This is absolutely independent of wind direction or the position of the sun, which may be at or near the zenith and therefore no guide at all. Gusts of wind will blow them out of their course temporarily, but they return to it with wonderful persistence."

An examination of the tabulated results of Mr. Evershed's observations, as shown in the Summary and figures 4 and 5, shows fairly well, I think, the following distinct points.

1. A very definite southerly migration of many species of Papilionidae (2 species), Pieridae (6 species), Danaidae (4 species), Nymphalidae (7 species), Hesperiidae (1 species), and dragonflies in the " autumn " from the end of August to the middle of November, but most usually in October. This period corresponds to the maximum rainfall and the change from the fairly definite S.W. monsoon to the less definite N.E. monsoon.

2. A more or less northerly migration of Pieridae only (*Catopsilia* and *Appias*) between February and June, possibly divided into two seasons by the month of April, but perhaps the absence of records for this month is accidental. This corresponds to the second half of the N.E. monsoon and the beginning of the S.W. monsoon.

3. A single record of *Euploea core* migrating to S.E. in March 1909, together with *Catopsilia crocale* and *pyranthe*. This is an abnormal direction for the

Catopsilias and the only record of a *Euploea*; Euploeas, however, as will be seen later, are regular migrants in Ceylon. The cold climate of Kodaikanal may have an influence here.

4. A very definite migration of the Lycaenid *Polyommatus boeticus* towards the S.E. in January, February and March 1911. Mr. Evershed tells me that he observed the same species again in the winter of 1920–21 going in exactly the same direction.

Further discussion of these will be found after the Ceylon records have been dealt with (see p. 28).

III. Ceylon.

Special Notes on Environment.

The Island of Ceylon, which is less than 100 miles from the southern point of India, consists of a flat plain extending inland for about fifty miles from all the coasts and also crossing the northern half of the island completely. The South Central area is occupied by a mass of mountains reaching to a maximum height of about 8000 feet (see Fig. 5).

The annual changes of temperature and rainfall in different localities are shown below and in Fig. 6. It will be seen that the seasonal changes of temperature are small, and variation within the island is chiefly due to changes in level.

Rainfall is high in the hills and on the south and west coasts. At Colombo and at Kandy there are two wet seasons in May and October, corresponding to the commencements of the S.W. and N.E. monsoons respectively.

The northern half of the island is, however, much drier and is liable to severe droughts particularly towards the end of the S.W. monsoon, owing to the mountains causing most of the rain to fall in the south-west and centre of the island.

Some typical figures for temperature and rainfall are given in the following table and in Fig. 6.

Average Monthly Temperature and Rainfall.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Temp. °C.												
Galle (S.W. coast).	25·7	26·3	27·3	27·7	27·7	27·0	26·6	26·7	26·7	26·4	26·2	25·8
Colombo (W. coast).	26·3	26·7	27·7	28·1	28·3	27·7	27·0	27·2	26·6	26·6	26·1	26·1
Trincomalee (N.E. coast).	25·9	26·9	28·1	29·5	30·1	29·7	29·5	29·3	29·1	28·0	26·8	25·9
Kandy (Hills).	23·6	24·5	25·7	26·0	25·9	24·8	24·4	23·9	24·3	24·3	24·1	23·6
Rainfall, mm.												
Galle	108	71	110	249	286	208	156	137	208	336	291	169
Colombo.	96	98	93	256	456	354	166	98	149	445	308	171
Trincomalee.	167	52	42	50	62	33	52	104	114	207	354	365
Kandy.	116	61	88	177	143	241	189	144	145	304	239	228

The general changes correspond to those of Kodaikanal, but the wet season in May is much more marked in Ceylon, except in the north and north-east, where this period is the driest season.

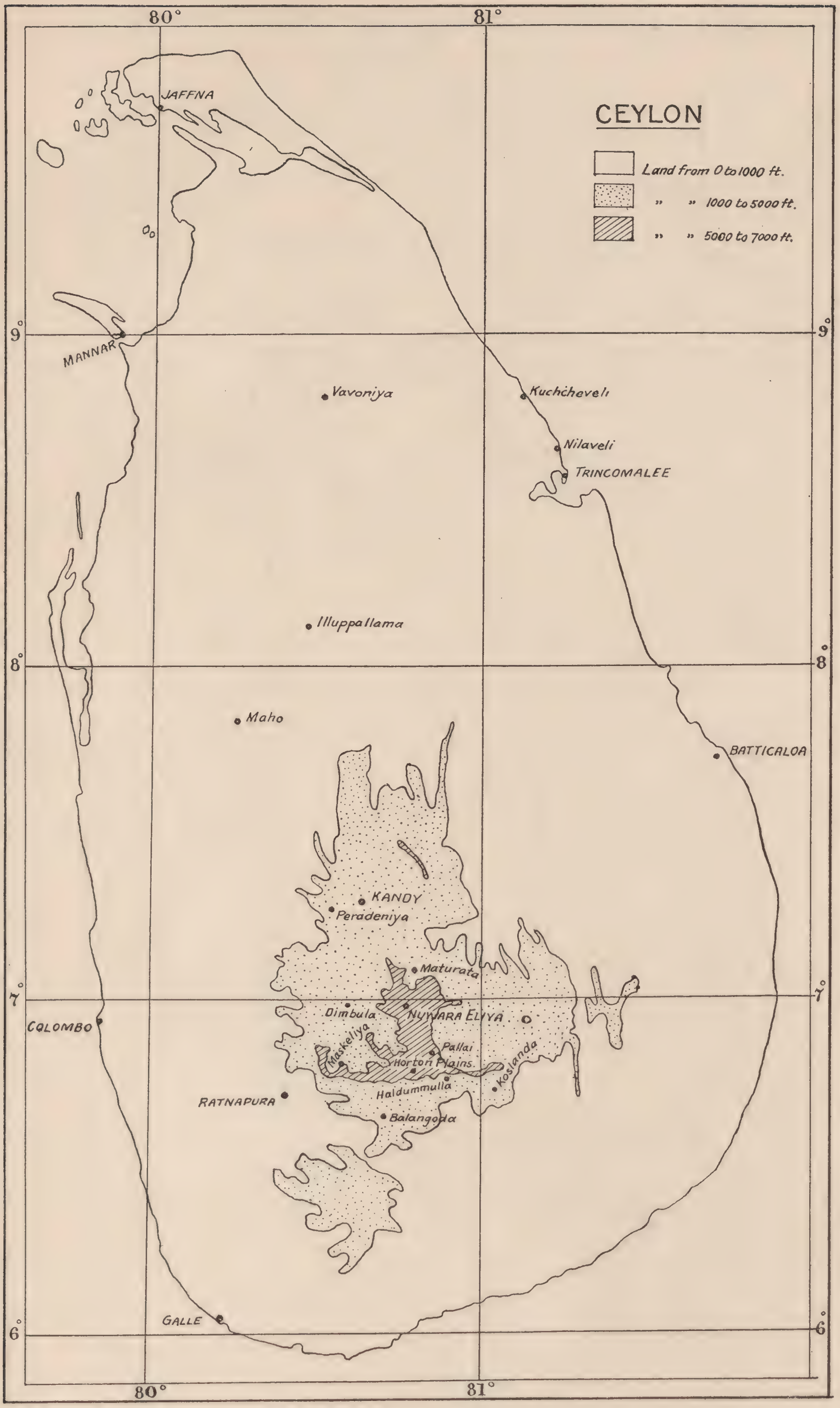

FIG. 5.—Map of Ceylon showing localities mentioned in text and contours at 1000 and 5000 feet.

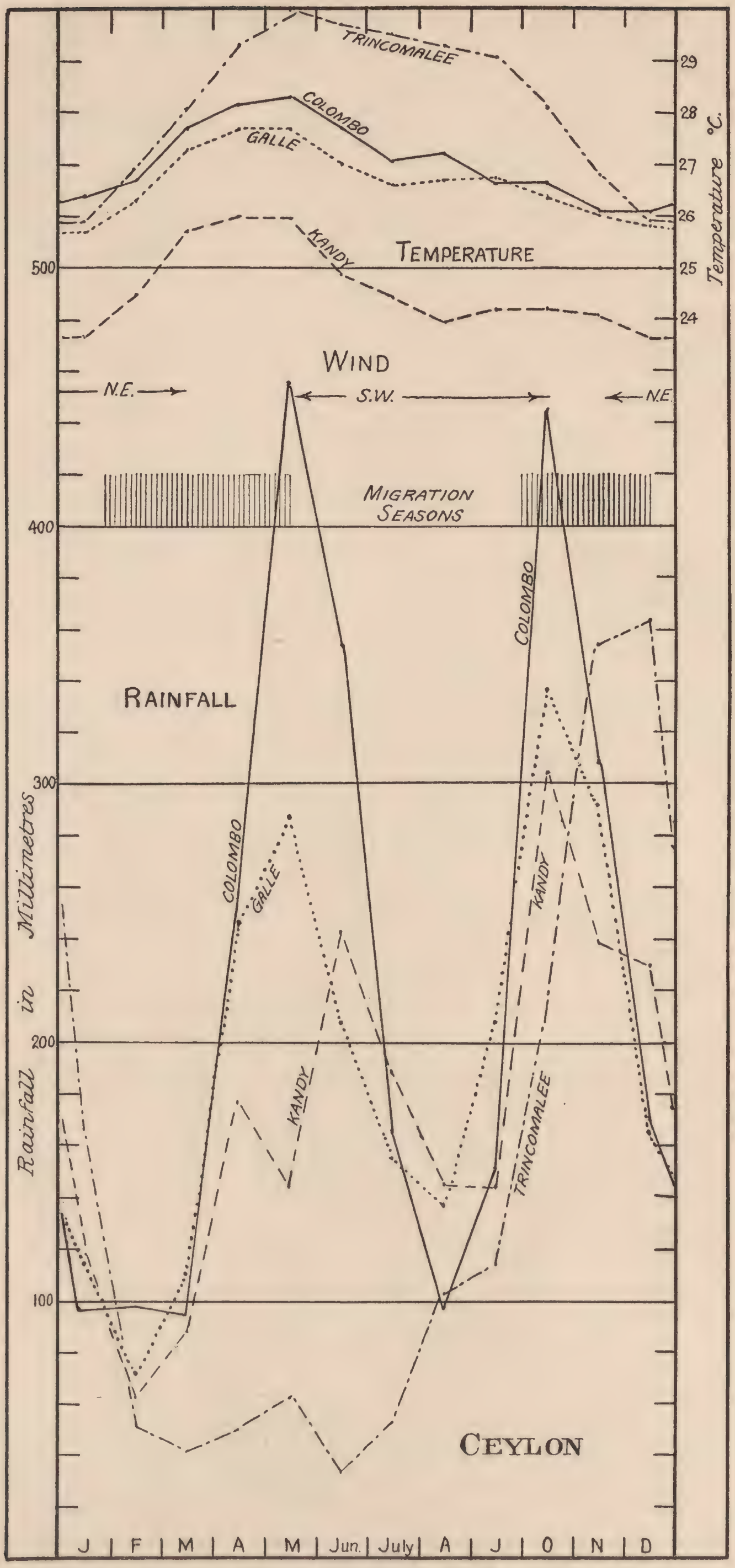

FIG. 6.—Diagram showing climatic features at several typical localities in Ceylon.

Summary of Records.

Summary of all Available Records of Butterfly Migration in Ceylon.

Date.	Locality.	Species.	Direction.	Reference.	Notes.
Before 1859.					
April and May.		*Callidryas hilariae, alcemone, pyranthe, Euploea coras* and *E. prothoe.*	Generally to N.E.	Tennent, 1859 and 1861.	
1865.					
Apr.	Colombo.	*C. crocale* and *catilla.*	N. to S.	Radley, 1893.	
Dec. 3.	Colombo.	Enormous cloud of white and yellow Catopsilias.	S. to N.	Holdsworth, 1872 (*b*).	Against N.E. monsoon.
Before 1872.					
"Each year" in Nov.	Colombo.	Mostly yellow and white, but many *Papilio hector* and *Ornith. darsius.*	To N.	Holdsworth, 1872 (*a*).	Against N.E. monsoon.
1878.					
Mid-Dec.	"Hill country."	*Appias albina.*	N.W.	M. B., 1879.	
1879.					
Mid-Jan.	"Hill country."	*Appias albina.*	S.E.	M. B., 1879.	
1884.					
Nov. 18–19.	Kandy and Ratnapura.	Yellow and white and dark-coloured butterflies [Catopsilias and Euploeas ?].		Cumming.	
1887.					
Nov. 18.	Nuwara Eliya.	Dark brown [*Euploea* ?].	S.W. to N.E.	Le Mesurier (Cumming).	Wind S.E. first flight of season.
Nov. 21.	Nuwara Eliya.	White and sulphur [Catopsilias and *Appias* ?].	N. to S.	Le Mesurier (Cumming).	Wind N.E.
Dec. 10.	?	Brown and white butterflies [*Euploea* and *Appias* ?].	To S.	Anon. (Cumming).	
1888.					
Nov. 18.	Colombo.	White and yellow and some dark.	To N.	Cumming.	In teeth of wind.
1889.					
Mid-Oct.	Dimbula.	Not stated.		Cumming.	
Nov. 5.	Colombo.	Dark brown and yellowish-white.		Cumming.	
Before 1893.					
Feb.	(? Maturatta).	*Isamia* (*Euploea*) *asela* with *Parantica ceylonica.*		Radley, 1893.	
About Apr.	Maturatta.	*C. catilla, crocale, pyranthe. Catophaga neombo* and *galena.*	N. to S.	Radley, 1893.	For about a week.
1893.					
Oct.	Wellawaya.	*Papilio nomius.*		Ormiston, 1924.	In hundreds on wet roads.
Before 1895.					
Nov.	Colombo.	*Catophaga galena.*	To. N.	Mitford, 1895.	Against wind.
1895.					
Mar. and Apr.	"Northern part."	*Catophaga galena.*	N.E. to S.W.	Mann, 1895.	
Oct. 25.	Colombo.	Catopsilias, etc.	To N.	Manders, 1904.	
Between 1895 and 1904.					
Dec. 2.	Trincomalee.	*C. pyranthe.*	To S.	Manders, 1904.	Laying eggs on route.
1899.					
Nov. 17–Dec. 21.	Peradeniya.	*Euploea asela* and later *Catopsilia* spp., including *C. catilla* and *Catophaga* sp. (*Appias*).	To N. to N.W.	Green MSS.	
Dec. 5.	Galle.	Catopsilias.	Due N.	Green MSS., quoting newspaper record.	"Annual flight began to-day."
1900.					
Feb. 27–Mar. 4.	Peradeniya.	*Catopsilia* and *Catophaga.*	To N.N.W.	Green MSS.	Wind slight N.E.
Nov. 20–23.	Peradeniya.	*Euploea montana* and *asela.*	To S.W.	Green MSS.	
1901.					
Mar. 16.	Anchored off Rameswarem Is. (Adam's Bridge).	*Papilio hector* and *Euploea* sp.	To S.W.	Green MSS.	
Nov. 26–Dec. 10.	Peradeniya.	*C. crocale, Euploea montana, Danaida limniace.*	W.N.W. except 3 days E.N.E.	Uzel, 1912.	

Summary of Records (continued).

Date.	Locality.	Species.	Direction.	Reference.	Notes.
1902.					
Jan. 12–14.	Peradeniya.	*Catopsilia crocale.*	N.N.W. and N.	Uzel, 1912.	
May 4.	Peradeniya.	Catopsilias.	W.N.W.	Uzel, 1912.	
May 24.	Peradeniya.	*Catopsilia crocale* (vast numbers).	To E. and S.E.	Green MSS.	Burst of S.W. monsoon expected daily.
Nov. 20.	Upper Maskeliya.	*Catopsilia* spp.	N.W.	Mr. Cuff (Green MSS.).	
Dec.	Haldummulle.	*Euploea sinhala.*		Ormiston, 1918.	For a few days the commonest *Euploea* in the flight.
1904.					
Mar. 5–7.	Peradeniya.	*Appias paulina.*	Confused but general trend N.W.	Green MSS.	
1905.					
Feb. 25–28.	Peradeniya.	*Catopsilia crocale.*	S.W. on first day, but later confused.	Green MSS.	
Mar. 16.	Peradeniya.	*Catopsilia* and *Appias.*	To E. or S.E.	Green MSS.	
Nov.	Colombo.	*Catopsilia pomona, crocale* and *pyranthe* vars. *gnoma, ilea* and *chryseis.*	S. to N.	Wickwar, 1906.	
Nov. 15–24.	Tellula (below Koslands, Uva).	*C. crocale, Appias paulina,* less numbers of *H. glaucippe, Ixias ceylonica, P. demoleus, jason, crino* and *aristolochiae* and a few *Euploea asela.*	North.	Green, 1906.	
1907.					
Oct. 18–21.	Sirigula (Uva) to Liangolla (E.).	*C. crocale* and *P. polytes* very abundant, also *P. nomius, crino, demoleus, Junonia iphita, Ergolis ariadne, H. australis, A. paulina, C. pyranthe, Castalius rosimon, D. limniace, Bindahara sugriva, Telchinia violae, E. asela, D. aglea.*	East.	Daniel, 1908.	
1908.					
Oct. 4.	Trincomalee.	*E. asela* and 2–3% *Danais septentrionis.*	N. to S.	Willey, 1908.	N.E. monsoon, rains started following evening.
1909.					
Oct. 1.	Peradeniya.	*Catopsilia crocale.*	To N.W.	Green MSS.	Two distinct forms, one about twice as large as the other.
Oct. 3.	Peradeniya.	Euploeas.	To S.W.	Green MSS.	Straggling flight.
Oct. 13.	Peradeniya.	*Euploea asela* and *montana.*	S.W.	Green MSS.	
1910.					
Mar. and Apr.	Kandy.	*Catopsilia crocale.*	N.W.	Uzel, 1912.	"Down valley."
Mar. 16.	Ratnapura.	Pierids.	N.E. to S.W.	W. Ferguson (Green MSS.).	First flight of season "exactly in face of monsoon."
Mar. 31.	Peradeniya.	*Appias* sp.	N.E.	Green MSS.	Small scattered flights.
Sept. 29.	Peradeniya.	*Appias.*	N. or N.N.E.	Green MSS.	A few strings against the wind.
1911.					
Mar. 5–6.	Peradeniya.	*E. asela, montana* and occasional *septentrionis.*	N.W. to S.E.	Fryer MSS.	After 4 days with rain.
Mar. 6.	Peradeniya.	*E. asela* intermingled with *montana* and *Danais septentrionis.*	S.E.	Green MSS.	Small flights.
Mar. 7.	Peradeniya.	*Appias paulina.*	S.W.	Green MSS.	Small flights.
Apr. 1–9.	Peradeniya.	*Papilio crino.*	To S.W.	Fryer MSS.	
Oct. 19–21.	Peradeniya.	*Papilio polytes* (*romulus* ♀ common, *polytes* ♀ scarce).	To S.W.	Fryer MSS.	
Nov. 15.	Vavoniya (N.).	*Appias* sp., *Catopsilia* sp., *Papilio polytes, jason, nomius, hector.*	Uncertain but tending southwards.	Fryer MSS.	Along road through jungle. Weather very wet.

Summary of Records (continued).

Date.	Locality.	Species.	Direction.	Reference.	Notes.
1911.					
Nov. 25–Dec. 7, about.	Peradeniya.	*Euploea asela* (*core*), *E. montana*, occasional *E. sinhala*. By 30th Nov. *P. polytes*, *C. crocale* and *pyranthe*, fair numbers also *P. demoleus* and Danaines. On 1st Dec. *B. mesentina*, *I. pyrene* and *H. nerissa* ovipositing on Capparis during migration.	S.W.	Fryer MSS.	Strong wind from N.E. on Dec. 1.
Nov. 25–30.	Peradeniya.	Euploeas at first and later with large numbers of *P. polytes*, *Atella phalantha* and Catopsilias.	To S.W.	Green MSS.	
1912.					
Mar. 1.	Peradeniya.	Chiefly Catopsilias and *Appias*, also a few *Euploea* sp., *P. polytes*, *Nepheronia* sp., *Terias* sp.	To W.	Green MSS.	
Mar. 1–22.	Peradeniya.	Catopsilias, *Appias*, *Terias hecabe* common, a few *Neph. ceylonica*, *P. polytes*, all forms not uncommon, also *P. hector*, *aristolochiae*, *L. calidosa*, *P. iphita*, *P. parinda*, *N. eurynome*, *H. nerissa*, etc. On 8–15th largely *A. paulina*.	N.E. to S.W.	Fryer MSS.	Poor in individuals but rich in species.
Mar. 30.	Peradeniya.	Euploeas and *A. paulina* and *albina* (including yellow form).	To W.	Green MSS.	
Apr. (3)–6.	Peradeniya.	*Euploea* 3 spp. and *Catopsilia* 2 spp.	To W.	Green MSS.	
Sept. 1.	Nilavilli-Keichivallis Road, N. of Trincomalee.	*Appias* sp., *Euploea* sp., *Papilio jason*.	? To S.	Fryer MSS.	
Nov. 12, 13, 21 and 23.	Peradeniya.	*Euploea* (including *asela*), *P. polytes*, *C. crocale*, occas. *D. limniace*, *P. crino* and *demoleus*.	To W.	Green MSS.	
Nov.	Maho to Ambanpola (N.C.).	*Hebomoia glaucippe australis*.	? To N.W.	Ormiston, 1924, and MSS.	Train passed for half-hour through many thousands.
1914.					
Early Dec.	Haldummulle.	*Kallima philarchus*.		Ormiston, 1918.	Plentiful for whole month.
1915.					
Aug.	Haldummulle.	*Deudorix epijarbas* and *Neopithecops zalmora*.	To W.	Ormiston MSS.	Specially large flight.
1916.					
Oct.	Haldummulle.	? *Hasora chromus* and *butleri*. ? *Badamia exclamationis*.	To S.	Ormiston, 1924, and MSS.	Evenings just before dark, none captured.
Oct. 24–Nov. 27.	Balangoda.	*Appias albina* and *paulina*, *C. crocale* and *Deudorix epijarbas*.	N.E. to S.W.	T. Graham Bell MSS.	Wind from S.W.
Oct. 24–29.	Nuwara Eliya.	? Catopsilias and *Appias*.	More or less S.	T. G. Bell MSS.	Wind from "Rambada Pass."
Oct. 26–Nov. 6.	Maskeliya, Gartmore.	Pierids.	To W.	T. G. Bell MSS.	Wind N.E.
Nov. 13–14.	Portmore Agrapatnas.	Pierids.	N.E. to S.W.	T. G. Bell MSS.	Wind S.W.
Mid-Nov.–Dec. 2.	Ratnapura.	"Snow-white butterflies."	To S.W.	A. G. Bering MSS.	Wind S.W.
1917.					
May.	Haldummulle.	*Sarangesa albicilia* and *Tagiades distans*.	To W.	Ormiston MSS.	
Nov.	Patipola.	*Deudorix epijarbas*.	To S.	Ormiston MSS.	Specially large flights.
Nov.	Patipola.	*P. agamemnon menides*.	To S.	Ormiston MSS.	Great numbers.
1925.					
Mid-Nov.	Peradeniya.	Large yellow Catopsilias and small white [? *Appias*].		S. C. Harland MSS.	On fine day in wet spell. No wind. Belt about 50 yds. wide.

Records according to Years.

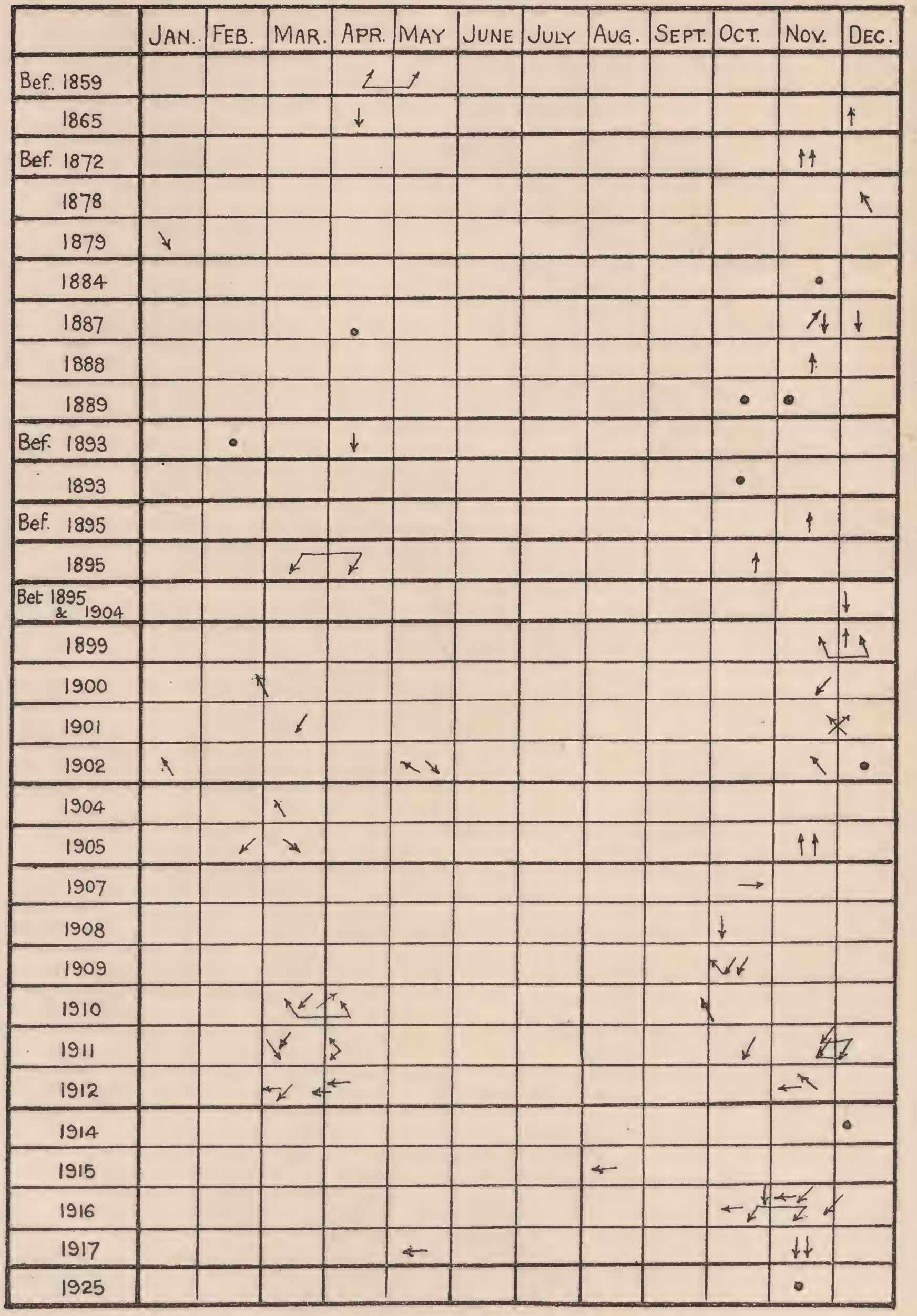

FIG. 7.—Records of migration in Ceylon showing year, month, and direction.

Records according to Localities.

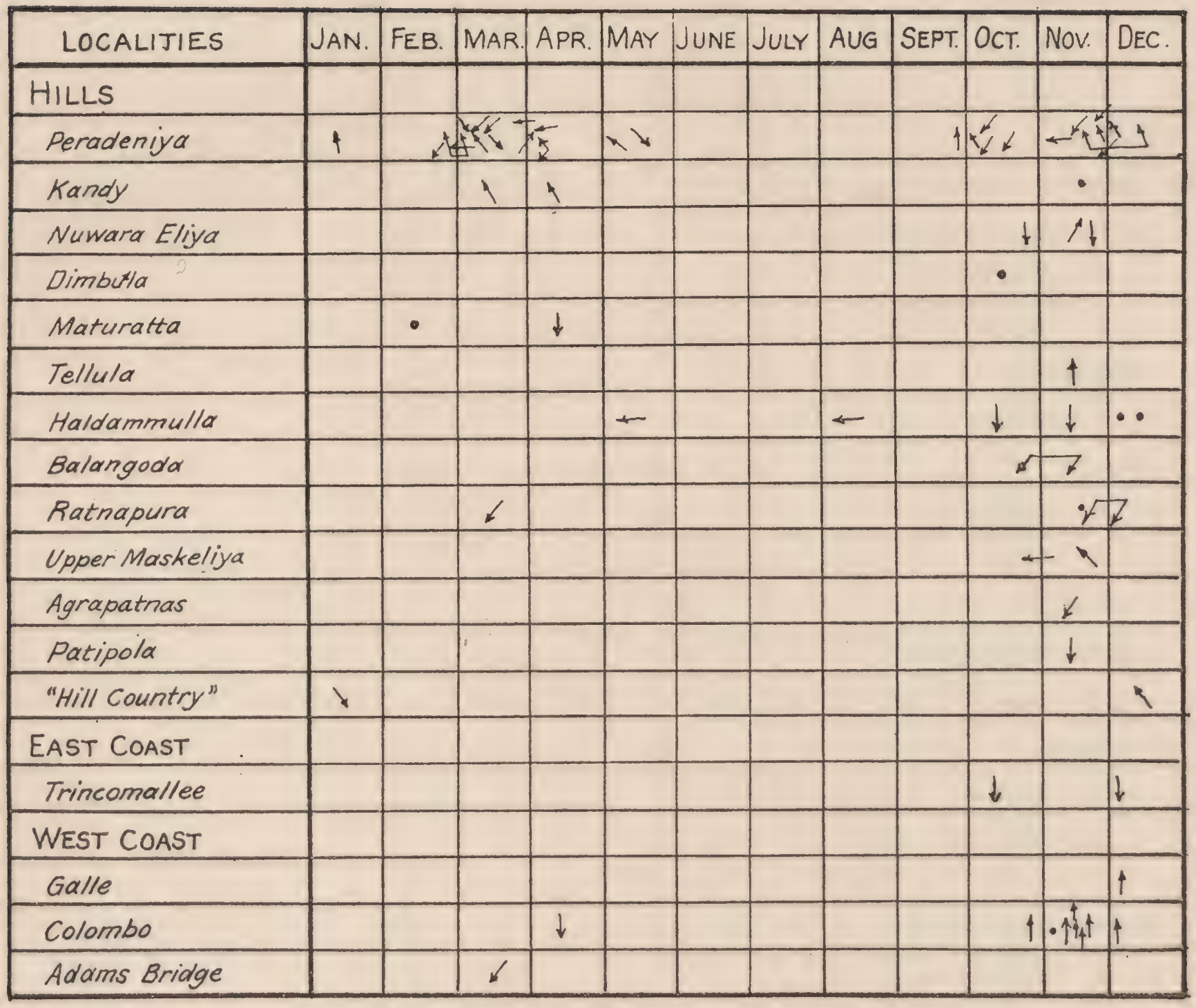

FIG. 8.—Records of migration in Ceylon showing locality, month, and direction.

Records according to Species at Peradeniya.

SPECIES	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
PAPILIONIDÆ			↙									
Papilio hector			↙									
» *aristolochiæ*			↙									
» *crino*				↕							←	
» *polytes*			↙	←						↙	←	↙
» *demoleus*											←	↙
» *parinda*			↙									
PIERIDÆ												
Catopsilia sp.		↖↙↗		←	↖						↗	↗↙↗
» *crocalé*	↑	↙			↘					↖	←	↙
» *pyranthe*												↙
» *catella*												↙↗
Terias sp.		←										
» *hecabe*		↙										
Appias sp.		←↙↗		↗					↑		↗	
» *paulina*			↙	←								
» *albina*				←								
Catophaga sp.		↖↗									↖↗	
Nepheronia ceylonica		←↙										
Huphina nerissa			↙									
DANAIDÆ												
Danais limniaceæ											←↙↗	
» *septentrionalis*			↙									
» *sp.*												↙
Euploea core asela			↙	←						↙	←↙↗	
» *kollari sinhala*				←								↙
» *coreta montana*			↙	←						↙	↙↗↙	
» *spp.*		←		←						↙	←↙	
NYMPHALINÆ			/									
Precis iphita			↙								↙	
Atella phalanta												
Limenitis calidosa			↙									
Neptis eurynome			↙									

FIG. 9.—Records of migration at Peradeniya showing species, month, and direction.

List of Migratory Species.

Up to the present no fewer than 69 species of butterflies have been recorded as taking part in the migratory flights in Ceylon, out of a total of 234 species recorded from the island in Ormiston's list of 1924.

A complete list of these is given below. The numbers and nomenclature are those used by Ormiston (1924). The 28 species marked with an asterisk are those about which the information was not sufficiently definite as regards the date to enable their records to be placed in the previous summary. The available information about these, together with some additional information on the other species is given in the next section.

Papilionidae.

174. *Troides (Ornithoptera) darsius.*
175. *Papilio (Menelaides) hector.*
177. *Papilio (Menelaides) aristolochiae ceylonica.*
178. *Papilio demoleus (erithronius).*
180. *Papilio polymnestor parinda.*
181. *Papilio polytes romulus.*
183. *Papilio crino.*
185. *Papilio nomius.*
186. *Papilio doson (jason).*
188. *Papilio agamemnon menides.*

Pieridae.

148. *Catopsilia crocale (catilla).*
149. *Catopsilia pomona (=hilariae).*
150. *Catopsilia pyranthe.*
*151. *Catopsilia florella (gnoma).*
*153. *Terias venata cingala* f. *rama.*
*154. *Terias hecabe.*
157. *Ixias pyrene cingalensis.*
164. *Anaphaeis mesentina taprobana.*
166. *Appias venusta (= albina) (= neombo).*
167. *Appias paulina (= Catophaga paulina) (= C. galene).*
*168. *Appias libythea.*
170. *Hebomoia glaucippe australis.*
171. *Huphina nerissa evagete (= H. phryne).*
173. *Pareronia valeria ceylonica (= Nepheronia ceylonica).*

Danaidae.

3. *Danaida limniace.*
4. *Danaida septentrionis.*
*6. *Danaida plexippus.*
7. *Danaida aglea (= Parantica ceylonica).*
9. *Euploea core asela.*
11. *Euploea kollari sinhala.*
12. *Euploea coreta montana.*

Nymphalidae.

Nymphalinae.

*30. *Charaxes psaphon.*
*35. *Euthalia nais.*
39. *Moduza (Limenitis) calidasa.*
*40. *Neptis jumbah.*
41. *Neptis varmona (= eurynome).*
43. *Precis (Junonia) iphita.*
*44. *Precis (Junonia) atlites.*
*46. *Precis (Junonia) hierta.*
*47. *Precis (Junonia) lemonias.*
*48. *Precis (Junonia) almana.*
*49. *Cupha placida.*
*52. *Cirrochroa thais lanka.*
*53. *Hypolimnas bolina.*
*54. *Hypolimnas misippus.*
*55. *Pyrameis cardui.*
58. *Kallima horsfieldi philarchus.*
*59. *Doleschallia bisaltide.*
61. *Atella phalantha.*
*63. *Ergolis taprobana.*
64. *Ergolis ariadne minorata.*

Acraeinae.

66. *Acraea (Telchinia) violae.*

Libytheidae.

*67. *Libythea myrrha rama.*

Lycaenidae.

*70. *Neopithecops zalmora.*
*73. *Chilades laius.*
*76. *Lycaenopsis puspa.*
*92. *Nacaduba atrata gythion.*
*97. *Lampides bochus.*
*102. *Lampides boeticus.*
109. *Castalius rosimon.*
*111. *Castalius decidea.*
137. *Deudorix epijarbas.*
144. *Bindahara sugriva.*

HESPERIIDAE.

191. *Sarangesa albicilia.*
193. *Tagiades distans.*
*194. *Tagiades litigiosa* (*atticus*).
229. *Hasora chromus.*
230. *Hasora butleri* (*alexis*).
232. *Badamia exclamationis.*

Additional Notes on Migratory Species.

PAPILIONIDAE.

Papilio hector.

" In November 1914 I saw a fair number far out to sea off the Indian and Ceylon coasts " (Ormiston, 1924, p. 103).

Papilio polytes.

With reference to this species at Peradeniya, Fryer writes in his notes (29th Dec. 1911): " The distribution of *Papilio polytes* through the year is very curious. For the first three or four months it may be described as ' not uncommon,' but afterwards it is exceedingly scarce until the October-December migration. Broods from the migrants presumably emerge during the early months of the following year and result in the species being not uncommon. It does not appear to be resident at Peradeniya throughout the year."

Fryer also notes that the migration cannot be caused by lack of food, as he found the food abundant in the low-country jungles around Maha Illupalama in both November 1911 and January 1912, " although it no doubt becomes short in the dry season," which would be July, August, September and early October, getting progressively dryer month by month.

Ormiston (1924) says: " It joins in the flights in great numbers especially in November and December, and I have noticed that in these flights the variety which mimics *hector* is usually the commonest. At Haldummulle *hector* is far less common than *aristolochiae*, but these flights were coming from the dry low country where the opposite is the case. When the flights are not on, the variety like *hector* is by far the rarest at Haldummulle, and the one like the male the commonest."

Papilio crino.

" I once saw a very big flight at Galle in March. The direction was S.W., viz. straight out to sea. It continued for three or four days. It had evidently come from the dry zone at least fifty miles away " (Ormiston, 1924, and in litt.).

Papilio nomius.

" Occasionally flights in fair numbers at the commencement of the N.E. monsoon (viz. October), and these flights sometimes reach the hills. I have noted it as flying west on the Trincomali-Anuradhapura Road " (Ormiston in litt.).

Papilio doson.

" Flights in great numbers at times, but the flights rarely reach the hills. All those found settled in river beds or on wet roads during the flights are males " (Ormiston in litt., Oct. 1925).

PIERIDAE.

Catopsilia crocale and **pomona.**

" The flights of *crocale* will be found almost always to consist of well-

grown specimens of 2 inches to $2\frac{1}{2}$ inches in expanse. In *pomona* on the contrary dwarfs of under two inches form the great majority" (Ormiston, 1924, p. 84).

"Both species flight in enormous numbers at least twice a year, especially in April and Oct. near the change of the monsoons" (Ormiston in litt.).

Catopsilia florella.

Ormiston (1924) puts *Catopsilia florella* = *gnoma*. There is one record in the summary of *gnoma*, but owing to the great confusion in these species it is not certain what insect is meant.

Ormiston, 1924, writes: "It is commonest at Haldummulle in Nov. and Dec., viz. during the N.E. monsoon flights."

C. florella is a well-known migrant in Africa.

Terias venata rama.

Ormiston writes (in litt., Oct. 1925): "Apparently flights at Haldummulle early in the year (February, March) going south. I don't think they go far and I am sure that the specimens bred at a lower elevation will be *T. venata* v. *cingala*. Var. *rama* is rare at Haldummulle (3000 feet), except during these flights, but it is plentiful four miles north at over 5000 feet."

Ixias pyrene cingalensis.

Ormiston (1924) writes: "An insect of the dry low country, but in some years it joins in the flights in Nov. and Dec. and may then be found anywhere. I have known it to be common at Haldummulle, Peradeniya and Galle, none of which places are its usual haunts."

In letter (October 1915) he adds: "It joins with December flights at Haldummulle in small numbers. All I have caught were males. It is never found at Haldummulle except during the flights."

Anaphaeis mesentina taprobana.

This race is peculiar to Ceylon, but is a race of *A. mesentina* which is found from Africa to India. *A. mesentina* has been recorded migrating in East Africa.

Ormiston, 1924, writes: "It is very variable, but seems to be well established as a race except in the north of the island. I have single specimens from Jaffna and Mannar, and have seen one from Anuradhapura which is very near typical *mesentina*, though the underside of the wing is chrome yellow in all."

It is much given to flighting, especially during the N.E. monsoon. During the flights it is common at Haldummulle, Colombo, Kandy and Galle, which are much further from its normal haunts than the distance across Adam's Bridge. So it is easy to understand the introduction of fresh blood from the parent species in the north.

Appias venusta and **paulina.**

"Flight in enormous numbers at least twice a year. The direction of the flight seems to depend on the wind and the configuration of the ground. I have noticed them in the low country flying in the afternoon in exactly the opposite direction to which they were flying in the morning" (Ormiston, 1925, in litt.).

Appias libythea.

Ormiston, 1924, p. 98, says: "It is normally an insect of the dry low

country, but often joins in the Nov.-Dec. flights and may then be found at any elevation."

Huphina nerissa.

" Flights at least twice a year, and is then common everywhere in the hills. I have seen it in swarms at Nuwara Eliya. I have not yet, however, observed it in the Galle district " (Ormiston, 1924, p. 99).

Pareronia valeria ceylonica.

" Joins in the flights in fair numbers at times at Haldummulle, always going north or N.W." (Ormiston in litt., Oct. 1924).

Danaidae.

Danaida limniace.

" Travels much faster than the other Danaines " (Ormiston in litt., 1925).

D. septentrionis.

" It usually shares with *Euploea asela* the honour of starting the N.E. monsoon flights. . . ."

" Occasionally during the flights hundreds of their wings may be found in places along the roads. I believe this to be mainly the work of the white-bellied Drongo (*Dicrurus leucopygialis*), as I have watched this bird catching them, eating the body and dropping the wings " (Ormiston, 1924, p. 3).

" One of the most numerous in all the flights " (Ormiston in litt.).

D. plexippus.

" Joins to a limited extent in the flights " (Ormiston, 1924, p. 4).

D. aglea.

" Joins to a very limited extent in the flights " (Ormiston, 1924, p. 4).

Euploea coreta montana.

" Almost as abundant as *asela* in the flights, but does not usually appear until they have been on for some days " (Ormiston, 1924, p. 6).

Nymphalidae.

Charaxes psaphon.

" The female is seen up-country far more often than the male, but it is then nearly always flying very fast."

" The females [of *Charaxes fabius*] do not seem to flight at high elevations like female *psaphon* " (Ormiston, 1925, p. 19).

Euthalia nais.

Ormiston, 1924, p. 21, writes : " Very rarely individuals seem to be infected with the migrating mania and may be met with a few miles from their haunts flying very fast and straight. These sometimes settle, but if disturbed go on straight away. I have noticed them in March and August on this estate [Haldummulle] going straight in the direction of Adam's Peak. If these are efforts to find new breeding-grounds they do not appear to be very successful."

In litt. October 1925, Ormiston adds that the March and August flights

were after long droughts and says: "The only breeding-ground I know for this species lies S. and S.W. of Haldummulle."

Neptis jumbah.

Ormiston in litt. (Oct. 1925) writes: "It apparently joins in the flights in Nov. and Dec."

Precis (Junonia) atlites.

Ormiston in litt. (Oct. 1925) writes: "Flights in great numbers . . . *atlites* has a peculiar habit of often travelling in exactly the opposite direction to that of the other species in the flight." He also states (1924, p. 26): "It appears up-country usually in Oct. before the regular flight begins and the swarm only lasts a few days."

Precis (Junonia) hierta.

Ormiston in litt. (Oct. 1925) writes: "Apparently flights, as it suddenly appears in quantity far from its usual haunts." He also describes (1924, p. 27) how it suddenly appeared all over the island in 1916, although from 1889–1916 he had seldom seen it out of the Northern Province. "They were all perfect specimens and did not appear to have flighted far." They remained common at Colombo till 1919, but disappeared from Kandy before this.

Precis (Junonia) lemonias.

Ormiston, 1924, p. 28, writes: "It is occasionally very numerous at Haldummulle during the N.E. monsoon flight, but in the low country it is plentiful all the year round."

Cupha placida.

Ormiston in litt. (Oct. 1925) writes: "Apparently flights."

Cirrochroa thais lanka.

Ormiston in litt. (Oct. 1925) writes: "Apparently flights."

Hypolimnas bolina.

Ormiston in litt. (Oct. 1925) writes: "Flights in large numbers in Nov. and Dec."

Pyrameis cardui.

Ormiston, 1924, says: "Single specimens may be seen anywhere all the year round, but in some localities great numbers suddenly appear, though it does not appear to flight. I have noted these big batches at Galle (twice) and at Jaffna."

Kallima philarchus.

Ormiston, 1924, p. 34, says: "Rare at Haldummulle except in December. The flight nearly always starts in Christmas week and only lasts a few days. In 1914 they arrived early in December and were plentiful for the rest of that month, but at a higher elevation they remained in fair numbers till April. During these flights they are common at the Horton Plains (over 7000 feet), but seldom seem to reach Nuwara Eliya. In parts of the low country they are often very abundant in July, but very few migrate up-country then." In litt. Ormiston writes (Oct. 1925): "If disturbed it usually goes on in a N. or N.W. direction."

Manders, 1904, writes : " *Kallima philarchus* annually migrates sometimes in large numbers, though it is usually considered a rare insect. So far as I can at present ascertain there is only one migration annually, in Nov. or early in Dec. The insects come up from the low country to Haldummulle, then up the passes leading to the Hortons, and then across the plains to some uncertain locality, but where I have no idea. The insect does not occur in the Colombo or immediate Kandy district nor about N'Eliya." This route is shown on Mander's map (reproduced in Fig. 10) as a heavy black line.

Doleschallia bisaltide.

Ormiston writes (in litt., Oct. 1925) : " Occasionally appears in fair numbers in the tea at Haldummulle in Nov. and Dec."

Ergolis taprobana.

" Flights in great numbers " (Ormiston in litt., Oct. 1925); " found at Haldummulle all the year round, but is only common during the flights " (Ormiston, 1924, p. 37).

Libytheidae.

Libythea myrrha rama.

" I have once noticed *L. myrrha rama* flighting west at Haldummulle in Nov. and Dec. The females were then as plentiful as the males. Usually they are much less so " (Ormiston in litt.).

Lycaenidae.

Chilades laius.

" Appears in great numbers at Haldummulle in Nov. and Dec. and apparently flights " (Ormiston in litt., Oct. 1925). " It may be taken at Haldummulle all the year round, but is only abundant during the N.E. monsoon flights, when it is often the commonest blue for a few weeks " (Ormiston, 1914, p. 42).

Lycaenopsis puspa.

" The female is very common at Haldummulle at times, and is apparently given to flighting. I have taken it here in every month but February and March " (Ormiston, 1924, p. 44).

Nacaduba atrata gythion.

" I have once seen a flight of this species. It was going W. and was entirely composed of extremely dwarfed specimens " (Ormiston in litt., Oct. 1924).

Lampides bochus.

" It is exceedingly abundant all over the southern half of the island and flies at Haldummulle all the year round. It often flights in great numbers and these flights are usually composed of dwarf specimens 22–25 mm. in expanse " (Ormiston, 1924, p. 57).

Lampides boeticus.

Ormiston, 1924, makes no mention of the species as migrating. In a letter to me (Oct. 1925) he says : " Is reported to flight, but I have never seen it." Fryer in a letter (July 1925) says : " I have never seen *L. boeticus* migrating, but

I remember noticing that on one occasion it suddenly appeared in numbers on Peradeniya racecourse where I had previously collected and had not seen it before. This was, I think, in Sept. 1911."

Evershed (above, p. 6) recorded it migrating in 1911 and again in 1921.

Castalius decidea.

" Apparently flights at times " (Ormiston, 1924, p. 64).

Hesperiidae.

Tagiades litigiosa (atticus).

" On the roads at Haldummulle large Skippers are often met flighting west. These flights are, I believe, almost entirely composed of *T. distans* and *atticus* " (Ormiston, 1924).

Discussion.

It will be seen by an examination of the records above that the migrations or flights in Ceylon are not so simple or straightforward as they are at Kodaikanal in S. India.

Owing to the great difference in different localities it is necessary to treat each locality, or at least each area separately.

An examination of the tabulated records for Peradeniya only (Fig. 9) and those tabulated according to locality (Fig. 8) shows that there are here also two main migrating seasons, the most important being the autumn one starting in October, but with its maximum in Nov. and Dec. The second main period of flight is from the end of February to the beginning of April.

A large number of species of different families seem to join in both these flights.

It is difficult to draw any very definite conclusions as there are only seventy-two definite records available for the island, over half of which are here given for the first time, and there is little doubt that an industrious observer could more than double that amount in a few years. Not until several hundred records are available will the conclusions be really interesting and reliable.

Taking the localities separately, most of the records refer to Peradeniya. Here we see from the Fig. 9 that the Nov.–Dec. flights include Papilionidae, Pieridae, Danaidae and Nymphalidae, and that while the direction of flight is variable the majority of actual records are towards the westerly quarter (*i.e.* between N.W. and S.W.). However, a few records exist in the exactly opposite direction.

In the spring migration at Peradeniya practically the same species of butterflies take part and once more the greater majority of the records are towards the west quarter (*i.e.* N.W. to S.W.) with a majority about W.S.W.

In most of the other localities (Fig. 8) there are too few records to be certain of any conclusions, but it is interesting to note that all the hill localities are more or less in agreement with Peradeniya, except that at Haldummulle we have two records of westward migrations in May and August. One of these (May 1917) relates to two species of Hesperiidae, and the other one (August 1915) to two species of Lycaenidae.

When we turn to the coast regions we find that the records, so far as they exist, refer to the same seasons, but the directions are extremely different.

At Colombo on the West Coast we have eight records, one of which refers

to a southerly direction in April and all the others to northerly flights in Oct. to Dec.

The species concerned are Catopsilias in the April flight (1865) and Catopsilias, *Papilio hector*, *Ornithoptera darsius*, *Appias* sp., and Brown butterflies (? *Euploea*) in the Oct.–Dec. flights.

At Galle on the S.W. coast we have only one record of Catopsilias flying north on 5th Dec. 1899, but it is accompanied by the statement that the "annual flight began to-day," so it is apparently a regular event and more details should be easily available if anyone on the spot were interested.

At Trincomalee on the East Coast we have two exact records only and both of these refer to Oct.–Dec. flights to the south. That is exactly opposite to those taking place on the West Coast at the same time. The species mentioned are Catopsilias in Dec. (between 1895–1904) recorded by Manders, and *Euploea asela* + 2–3% *Danais septentrionis* in Oct. 1908 recorded by Willey.

As stated in the introduction the only previous attempt to describe broadly the migrations in Ceylon was made by Manders (1904), and he gives in a map the conclusions he had come to after several years' experience. Unfortunately however, he gives none of the exact observations on which his conclusions were based, nor does he distinguish between the spring and the autumn flights.

His map, reproduced by permission of the Entomological Society in Fig. 10, shows a flight line of *Catopsilia pyranthe* and *crocale*, *Papilio jason* and *demoleus*, *Euploea asela*, etc., southwards down the east coast of the island, westward across the south coast, and northward up the west coast. He adds: "The road between Trincomalee and Kandy, which runs through dense forest, is also largely used by the migrating insects," but he does not add this to his map.

So far as these directions refer to the autumn flight they are more or less in agreement with the observations summarised above, although Manders seems to have underestimated the extent of the W. or S.W. flight in the centre of the island.

Manders adds: "The proof that the insects on the Trincomalee side really do follow the coast line and come to Colombo is shown by the fact that it is only during the flights that certain butterflies otherwise confined to that portion of the island, *Papilio jason*, for instance, occur at Colombo, and are there seen migrating in the same frantic haste as their companions."

Manders next gives in his map a line of flight for *Kallima philarchus*. This is in general agreement with the remarks of Ormiston quoted above, p. 23.

Manders' third line of flight is that of *Appias albina* and *paulina*. According to Ormiston these flight at least twice a year, but the actual records available are more frequent in the March migrations than in the autumn. At Peradeniya they are mostly to W. and S.W. in March with two records to N.E. in the autumn. Other records in the hills are S.E. in January at "Hill Country"; S. in April at Maturatta; S.W. in October at Balangoda; N. in November at Tellula and N.W. in December in the "Hill Country."

Records in other localities for *Appias* sp. are to S.W. in March and April in the "Northern Part," to E. in October along the road from Sirringula to Liangolla (East), and to North in Colombo in Nov.

It appears impossible at present to draw any conclusions from this. All observers are agreed that flights of any species are rare in the northern portion of the island.

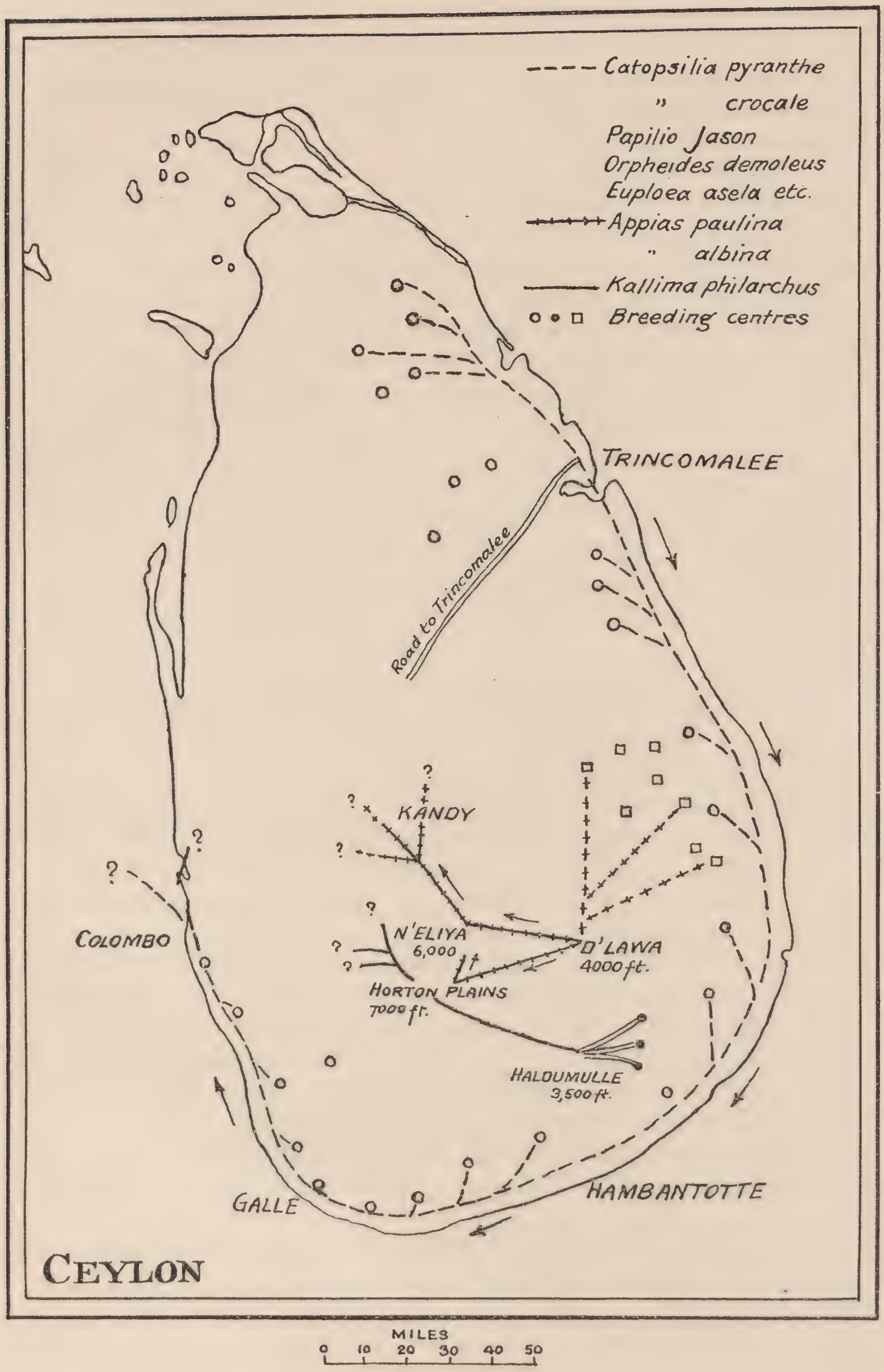

FIG. 10.—Colonel Manders' map of migration routes in Ceylon, reproduced from the *Trans. Ent. Soc.* for 1904.

IV. General Discussion.

Comparison of Ceylon and South India Migrations.

The only species of butterflies recorded migrating at Kodaikanal which do not also migrate at Ceylon are *Junonia orithya* and *Parnara mathias*. The former occurs in Ceylon, but does not join in the flights, the latter was only once recorded in the flights in Kodaikanal.

The two main flighting seasons are distinct in both localities, but the "spring" flight in Ceylon is at its maximum in March and very seldom extends after April. In Kodaikanal there was a distinct recrudescence of migration in May and June which has no counterpart in the Ceylon records.

The flight at the end of the year appears to be distinctly earlier in Kodaikanal than in Ceylon. In the former locality it may occur in September, is at its maximum in October, and there are no records after the middle of November. In Ceylon there are no records before the beginning of October, the migration is at its maximum in November and persists till past the middle of December. Ceylon appears in this flight to be about one month later.

There are also interesting differences in the species which are concerned in the two flights. In Kodaikanal species of all families take part in the autumn flight, but only the Pieridae are in the spring flight. In Ceylon on the other hand practically every species which occurs in the Nov.–Dec. flights also occurs in the March flights. This is well shown in the difference between figures 5 and 9.

Still more striking is the difference between the direction of the two flights in the two localities. In Kodaikanal (Fig. 5) the October flight is very definitely to the south and the March flight to the north. The May–June flight, if it is distinct from the March flight is also towards the north.

In Ceylon we have not enough records for any one locality except Peradenyia to draw any definite conclusions, and at this place both flights are more confused; but in both, the majority of records refer to flights towards the westerly quarter (*i.e.* between N.W. and S.W.), *i.e.* they both appear to be in the same main direction, and nothing indicates a return flight of the same species.

At Colombo the flights appear to have a more definite direction and all records in the Nov.–Dec flights are towards the north. The only March record is in the opposite direction, but refers to the year 1865. Manders makes no reference to southerly flights at Colombo. The main direction of the Nov.–Dec. flights here is exactly the opposite to those at Kodaikanal, but the same as the isolated record from Madras quoted above (p. 9).

For Trincomalee on the East Coast we have only two records, both of the autumn flight and both to the south: opposite to Colombo and the same as Kodaikanal.

It is obvious from these few comparisons that we are still far from having enough evidence to draw any sound conclusions.

The Relation to Climate.

In Figs. 2 and 6 are shown diagramatically the rainfall, temperature, winds and migration seasons at Kodaikanal and Ceylon respectively. Can any relation be found between them?

As explained above, the main determining factors in the climate of this area are two monsoons, the S.W. starting about May and the N.E. starting about November.

The Oct.–Dec. flights appear to correspond very closely with the commence-

ment of the N.E. monsoon. The butterflies in this flight are frequently alluded to as "monsoon butterflies." Ormiston, writing 4th October, 1925, says: "The flights should have been here by now, but the S.W. monsoon has returned and put them off. I hear of great numbers in the low country preparing to flight as soon as the N.E. monsoon sets in." Several other records given above both for Kodaikanal and Ceylon emphasise this close relation.

The flights in March also correspond more or less with the break-up of the N.E. monsoon, but before the heavy rains associated with the regular set in of the S.W. monsoon occur.

In Kodaikanal the monsoon winds are less definite, but the October flights correspond fairly definitely with the setting in of the N.E. monsoon and occur in the month of maximum rainfall (but not of maximum cloudiness). The March flights occur at about the minimum rainfall when the N.E. monsoon is beginning to fail and the May–June flights appear to occur just before the setting in of the S.W. monsoon.

Although there appears to be some definite correlation between the flights and these seasonal changes, there appears to be little or no evidence that it is the direction of the wind that influences the direction of the flight.

Evershed in litt. says: "I consider that I had ascertained quite definitely that the direction of flight was independent of the wind."

The records in Ceylon, where they are apparently flying down one coast at the same time that they are flying up the other and across the middle of the island, is also fairly conclusive, as also is the flight to the north at Madras, while the main flight at Kodaikanal was to the south.

Evershed suggests in a letter that the temperature changes may have some influence on the flight: "Although the annual range is small there is nevertheless a very distinct winter and summer season both on the plains and at higher elevations in the hills. In June and July migrations are not much in evidence at Kodaikanal simply because the weather is cloudy and cold with much fine rain and fog." In Ceylon also the S.W. monsoon period is that of the greatest cloud.

However, whatever be the cause of the flights we must look for it in the locality where they originate. In the case of Kodaikanal one presumes that they originate in the plains to the north and south of the Pulney Hills, but at present there is no evidence as to how far we are to seek.

With regard to the migrations in Ceylon, Fryer (in letter 25th July, 1925) writes: "My impression is that in Ceylon the important migrations which were seen at Peradeniya all originated in the low country of the northern half of the island. Their direction of flight while passing over the central massif would be varied by local conditions and wind. The northern half of the island gets very dry towards the close of the S.W. monsoon. On the other hand, the southern low country gets all the rain of the S.W. monsoon and, as far as I recollect, never dries out like the northern. I think that on the whole in spite of certain contradictions the movements are due to weather effects, specially to drying out. It would therefore be natural that the movements from N. to S. should be large and the return slight."

Manders (1904, p. 70) also expresses, although rather vaguely, a somewhat similar view that the movements originate owing to the drying out of the food supply. According to the map he allows the flights to originate all round the central districts of the island, but more particularly in the north-east.

Fig. 6 shows the rainfall at Trincomalee during the S.W. monsoon to be extremely low, but the March flights occur quite at the beginning of its dry season, when vegetation should be still luxurious and the November migrations

more or less coincide with the renewal of the rains. One would expect the greatest drought in July to September. If, however, the renewal of the rains caused pupae to hatch that had been delayed owing to the drought one could see why the flight took place later.

Evidence of Interchange between India and Ceylon.

There is in the summary of records given above only one referring to butterflies at sea between India and Ceylon.

Radley, however, notes that large flights of yellow butterflies have been observed out at sea out of sight of land off the coast of India and Ceylon. And Holdsworth (1872 *a*) says that he believes that there is a regular migration of *P. hector* from India to the N.W. of Ceylon, and states that from the middle of February to the middle of April he was usually at sea cruising in the neighbourhood of the pearl banks, and that during three seasons he saw, at a distance of from ten to fifteen miles from land, struggling parties of *P. hector* flying low and steadily towards the coast of Ceylon in a direction nearly due east. They were more usually observed at the end of February, at the beginning of the short calm season between the monsoons. The distance from India to the part of Ceylon to which these hundreds of butterflies were making their way was not less than 60 miles.

The absence of records for other species may be due to the fact that they do not often fly across or merely to the absence of observers. Time alone can provide the definite information.

In the meantime, however, there is another interesting method of study by which we can infer with some accuracy whether or not interchange does take place.

In Ceylon there are about two hundred and thirty-six species of butterflies of which no fewer than sixty-nine have been recorded as joining in the flights. Some of these butterflies have wide ranges; others are unknown outside Ceylon; while others, on the other hand, are local Ceylon races of species which occur on the mainland of India.

The following table shows the distribution of these different types among the migrants and non-migrants of the different families.

	Migrants.			Non-migrants.		
	Found in India.	Ceylon races.	Ceylon species.	Found in India.	Ceylon races.	Ceylon species.
Papilionidae . .	6	3	1	1	2	2
Pieridae . . .	11	3	0	12	2	1
Danaidae . .	5	2	0	1	1	3
Satyridae . .	0	0	0	9	1	6
Morphinae . .	0	0	0	0	1	0
Acreinae . . .	1	0	0	0	0	0
Libytheidae . .	1	0	0	1	0	0
Erycinidae . .	0	0	0	1	0	0
Nymphalinae . .	15	4	1	6	4	7
Lycaenidae . .	10	0	0	45	11	10
Hesperiidae . .	4	1	1	30	4	6
	53	13	3	106	26	35
		69			167	

We see from this that of the thirty-eight species peculiar to Ceylon only three have been recorded migrating. These are *Ornithoptera darsius*, *Charaxes psaphon*, and *Sarangesa albicilia*.

Assuming that new species are more liable to develop or establish themselves under isolation than with free interchange, it appears clear that the isolation is less severe in the migratory species than in the non-migratory forms. This can only be caused by the more frequent interchange of specimens between the island and the mainland, unless migratory species are less likely to produce variants, or unless the migrant species are more recent arrivals on the island.

On the other hand, the fact that thirteen migratory species have developed races or subspecies in Ceylon is evidence against the fact that in these at least the butterflies fly regularly to or from the mainland.

Further Information Required.

When further information is required in every branch of the subject it is difficult to specify particular lines of work. However, the most fundamental point requiring solution in both S. India and Ceylon is the localities at which the swarms originate, as it is here if anywhere that we must look for any external factors that may cause the migratory instinct to develop.

In Kodaikanal an important point to settle is the question of the two migration swarms in March and May, and whether the break in April is real or due to lack of observation.

The next important point is the question of flight between India and Ceylon if it occurs and when. More observations are specially needed on the line of islands forming Adam's Bridge.

Another point on which data is sadly lacking is the question of the sexes of the butterflies taking part in the flights and the state of sexual development. If some observer on the spot would catch and dissect some hundreds of butterflies in the different flights and tabulate the sex and the state of development of the sex organs we would be one big step nearer to understanding a problem which at present seems almost beyond our grasp.

For the rest, what is required is more and more facts. At the least just details of locality, date, direction, and species concerned; and at most, as much information as can be gathered on every ramification of the subject. But records of either type must be in hundreds rather than in dozens. If this paper helps to interest people and produce further evidence more rapidly it will have achieved its main purpose.

V. Summary.

This paper is a survey of all the known information about unidirectional flights or " migrations " of butterflies in the extreme south of India and Ceylon.

For Kodaikanal in S. India a series of observations made by Mr. J. Evershed are given for the first time. For Ceylon all the published records are summarised together with new information from the MSS. notes of Mr. E. E. Green, Mr. J. C. F. Fryer and Mr. W. Ormiston.

At Kodaikanal the records show a regular flight of about 21 species of Papilionidae, Pieridae, Danaidae, and Nymphalidae towards the south, starting occasionally as early as the end of August or September, but usually at its maximum in October and ceasing about mid-November; and a northerly flight of Pieridae only in Feb.–March and also May and June. A Lycaenid has also been recorded migrating S.E. in Jan., Feb. and March in two years.

The November flight is about the beginning of the N.E. monsoon, the Feb.–March flight is just after the middle of this monsoon period, and the May–June flights about the beginning of the S.W. monsoon.

In Ceylon about sixty-nine out of a total of 234 species known in the island have been recorded taking part in the flights. The two main migration seasons are Oct.–Dec., and Feb.–April. They correspond to the beginning and end of the N.E. monsoon. Species of all families appear to take part in both flights. The directions of the flights are different in different parts of the island.

The November flights are confused, but chiefly towards the west (N.W. to S.W.) in the hills as at Peradeniya; southwards at Trincomalee on the East Coast, and northwards at Colombo on the West Coast.

The March flight is also confused in the Peradeniya district, but again chiefly to the westward. On the East Coast there is practically no information. On the West Coast the only record refers to a southerly movement.

There are many exceptional flights which do not fit into the general scheme.

Nearly all the species recorded at Kodaikanal also migrate in Ceylon, the chief differences being that the "November" flight is about one month later in Ceylon than in Kodaikanal, and there are no records of flights in May and June in Ceylon. Also the species in the spring flights are much more numerous in Ceylon.

The times of the flights appear to bear some correlation with the changes of the monsoon seasons, but what this is is not clear. It has been suggested that the flights originate owing to drying up of food plants, but this also appears doubtful.

The general opinion is that most of the Ceylon flights originate in the northern half of the Island, which is also the driest.

There is little direct evidence of flights between India and Ceylon, but it is interesting to note that only three out of the sixty-nine species recorded migrating are species peculiar to Ceylon, while thirty-five of the one hundred and sixty-seven non-migrants are peculiar. This appears to be indirect evidence of the greater isolation of the non-migratory species.

Further information is needed on every point before reliable conclusions can be drawn.

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THE MALE GENITALIA OF THE HEPIALIDAE

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Plates I–III.

Introductory.

The following paper is intended to embrace (1) a general consideration of the male genitalia of the Hepialidae and (2) a detailed description of the male genitalia of the New Zealand species of the family.

As has long been recognised, the Hepialidae, though presenting extreme specialisation of the mouth-parts, are in reality one of the most primitive groups of the Lepidoptera. A study of the genitalia shows that here also great specialisation has taken place, though in this case the change has been brought about by an increase in the complexity of the parts and not by reduction, as in the organs of the mouth. Eyer (*Annals of the Entomological Society of America*, vol. 17, p. 275) has given a valuable account of the male genitalia of the family and furnished a number of figures, but in the present writer's opinion he has fallen into error in one important particular. This is in connection with the aedeagus, and will be discussed in due place.

1. A General Description of the Male Genitalia of the Hepialidae.

The Eighth Segment.

In the Hepialidae the genitalia are normally almost entirely withdrawn within the eighth segment, and that segment has undergone more or less modification. The median portion of the eighth sternite is frequently strongly chitinised and forms a rather flat and shield-shaped plate lying beneath the vinculum. In *Perissectis* there is a peculiar development, a heavily chitinised flap being turned in at an angle of about 45 degrees from the caudal margin (fig. 10, *g*). The eighth tergite is usually puffed out dorsally, bulging over the tegumen, and generally bears an armature of moderate sensory hairs or scales. The chitinisation is weak and the conjunctiva is not well differentiated from the tergal area. In some cases, however, as in *Hectomanes bilineata*, Walk. (fig. 12, *b*), there is a small rather strongly chitinised area just above the dorsal division of the tegumen. In *H. fusca*, Luc. (fig. 14, *b*), this is not present, but there is a pair of more elongate areas which curve round and between the dorsal bases of the tegumen. *Charagia virescens*, Dbld. (fig. 5, *b*), exhibits two irregular well-chitinised strips running across the caudal portion of the eighth tergite; the shape of these can best be understood from the figure.

The Tegumen.

The tegumen in the Hepialidae consists of two latero-dorsal chitinised pieces, the dorsal connection being only membranous. In general the inner margins of these two pieces are produced towards each other and then angled

caudad, the effect being to form a flange which encloses a more or less oval portion of the upper caudal membrane. Frequently the ventral extremities of the tegumen end in paired processes (forming the " suspensorium " of Eyer), the lower or inner pair being strongly attached to, or even fused with, a special organ which it is proposed to call the " trulleum," by reason that in many instances it takes the form of an inverted basin. The whole of the tegumen is strongly chitinised, the lower portion particularly so. The caudal margins may be smooth, serrate or irregularly dentate and occasionally a small finger-like lobe may project from the inner dorsal angle. Lying along the cephalic margin, sometimes closely approximated to it, at others rather widely separated from it, is a narrow strip of chitin. Probably this sclerite is a chitinised part of the conjunctiva, but it may be a portion of the tegumen which has become separated by a secondary suture from the main organ.

In the upper part of the area enclosed by the expanded margins of the tegumen is the termination of the hind-intestine. The HEPIALIDAE do not, as far as is known, partake of any food during the mature state and it would seem that the nature of their mouth-parts precludes the possibility of feeding on any kind of sustenance. I have, however, noticed faecal matter in the hind-intestine on several occasions, but this may well have been of a similar nature to that usually found in the intestinal canal of moths which have just emerged from the pupa. Efforts to expel this faecal matter from the macerated abdomen did not prove successful, and it is therefore probable that the anus is imperforate. There is, however, in some species what appears to be the remains of a reduced anal tube (fig. 19, *a*).

The Aedeagus.

The aedeagus is entirely membranous, as is the contained penis, which is not differentiated from the ductus ejaculatorius. Its orifice is usually just above the lower end of the oval field formed by the flange of the tegumen.

The Trulleum.

The structure now to be discussed is regarded by Eyer as the aedeagus, but the carrying out of the present investigation has led the writer to conclude that the real aedeagus is membranous, and has no connection with the organ under notice. Owing to its delicate nature the aedeagus is not easily seen after maceration, and if that process is unduly prolonged it may be destroyed. It is also very easily torn away in dissection, but by careful manipulation I have been able to trace the organ in every genus examined. It does not connect with the trulleum, but passes above it to the orifice between the processes of the tegumen as described above. In *Charagia* and *Leto* the trulleum is absent, or rather it is present as a flat, tough, membranous plate connecting the juxta with the tegumen. (It may be noted in passing that, in the HEPIALIDAE, the membrane connecting the various parts of the genitalia is usually tough and strong.) In *Trictena* (fig. 11, *f*) the trulleum has become fairly well chitinised, but it is still a flat plate; in *Sthenopis* (figs. 7, *f*, and 8, *f*) the structure is less strongly chitinised but has assumed an altered shape, being deeply constricted towards the base and variously modified on the apical portion. This genus has proportionately smaller genitalia than any other examined and in *S. thule*, Stkr. (fig. 8), the chitinisation of the whole of the parts is the weakest to come under notice. *Oncopera* (fig. 9) and *Perissectis* (fig. 10) both exhibit small trullea of somewhat similar shape, being narrow and with the apex deeply

bifid. *Porina* (figs. 16 to 27) possesses the typical inverted basin-shaped trulleum, varying little throughout the genus. *Phassus* (fig. 6) also shows much the same formation, but in *Hectomanes* (figs. 12 to 15) the structure is entirely different from that of any other genus. It has become a curved process, flat on the basal fourth or so, and rounded for the rest of its length. Unlike all other Hepialid genera examined the trulleum in *Hectomanes* is but slightly attached to the tegumen. Judging from Eyer's figure (*Proc. Linn. Soc. N.S.W.*, vol. 50, p. 269) of the genitalia of *Palaeoses scholastica*, Turn., the only known representative of the PALAEOSETIDAE, there is close resemblance between the trullea of these two forms, and it also appears to the writer that the elaborate organ of the PROTOTHEORIDAE is but a further development of the same type.

The trulleum is always attached basally in a hinge-like manner to the apex of the juxta and its apex in turn is connected with the tegumen, usually with the inner or lower processes. In some instances there is complete fusion, so that dissection is not possible without breaking the parts. In no instance, however, is there the least difficulty in separating the structure from the true aedeagus.

But if the trulleum is not the aedeagus, or a part of it, what does it represent? It does not seem possible to homologise the organ with any known structure in the male genitalia of the Lepidoptera, and I would suggest that it is simply a development of the connecting membrane beyond the apex of the juxta. In the HEPIALIDAE the juxta does not fulfil the usual function of the organ in the Order, that of supporting or guiding the aedeagus; its situation precludes that and at the same time leaves abundant room for the development of an organ between its apex and the aedeagus. In *Charagia* and *Leto* we find only a toughened membrane in this area, but in the other genera this becomes gradually chitinised and shaped into the variety of forms as illustrated in the figures here given.

The Juxta.

The juxta, in the HEPIALIDAE, is seen in its simplest form in some species of *Charagia* (figs. 2, 4 and 5, *e*), where it is a wide but not deep band with a small indentation on its upper margin. In *Leto* (fig. 1, *e*) and *Sthenopis* (figs. 7 and 8, *e*) it is also of more or less simple quadrangular shape, but may here be deeper than broad, while in *Trictena* (fig. 11, *e*) and *Oncopera* (fig. 9, *e*) it tends to be shield-shaped. *Phassus* (fig. 6, *e*) has the upper angles produced into broad rounded lobes. In *Porina* the juxta varies from the quadrangular shape of *P. fusca*, Philp. (fig. 16, *e*), to the 4-lobed figures of *P. characterifera*, Walk., and *P. jocosa*, Meyr. (figs. 18, *e* and 20, *e*), the latter form being brought about by the marginal indentations. *Hectomanes polyspila*, Meyr. (fig. 15, *e*), has a plain oblong juxta, but in *H. crocea*, Luc., and *H. fusca*, Luc. (fig. 14, *e*), this has become very broad basally, while *H. bilineata*, Walk. (fig. 12, *e*), has developed a complicated structure which it is easier to figure than to describe. It may be noted that in this genus the juxta bears a median keel on its cephalic surface. A most unusual form of the juxta is exhibited by *Perissectis* (fig. 10, *e*), where the structure takes the basin-like form, though not inverted, of the trulleum in *Porina*; it would almost certainly be taken for that organ if examined without reference to its normal position.

The Harpes.

Throughout the HEPIALIDAE the harpes tend to be short, in few instances extending beyond the flange of the tegumen; in *Hectomanes* (figs. 12 to 15, *c*),

however, they are comparatively long and large. They may be quite simple and lobe-like structures, as in most species of *Porina* (figs. 16 to 27), or more thumb-like, as in *P. dinodes*, *Phassus*, *Sthenopis*, *Trictena* and *Leto*. Except in *Perissectis australasiae*, Guen. (fig. 10, *c*), and some species of *Oncopera* (fig. 9, *c*) there is no division of the organ into cucullus and sacculus, for the curved prongs of *Charagia* cannot be so considered. As has been noted above, the harpes in *Hectomanes* are proportionately large. They are usually very broad, and bend round upwards, so that their apices lie opposite the top of the tegumen. The ventral basal angles are often dilated and in some species, as *H. bilineata*, Walk. (fig. 12, *c*), there is at this point a short curved tooth.

The Vinculum.

The vinculum may vary from a rather narrow to a low and broad U-shaped structure, the lateral arms being usually more or less incurved apically. In some genera a saccus is present; in *Porina* this is usually broad and deep, *P. dinodes*, Meyr. (fig. 27), reaching the highest development in this respect. The lateral arms are generally broad and thick and may be either pointed or obtuse; in *Hectomanes* alone is the vinculum rather feebly developed, the ventral portion being slight and the arms thin. Some peculiar outgrowths should be noted. In *Trictena* (fig. 11, *d*) there is a pecten-shaped flat lobe, directed outwardly, just above the bases of the lateral pieces, and in *Sthenopis* (fig. 7, *d*) there is at the same point a somewhat conical process directed caudally. *Charagia* exhibits the progressive development of the caudal membrane between the bases of the arms into a pair of leaf-like structures (figs. 2, 4 and 5, *d*), and *Phassus* (fig. 6, *h*) displays a complicated median piece in the same position.

Conclusions.

Having regard to the absence of an intromittent organ, the extraordinary modification of the tegumen, the position of the juxta, the strong connection (sometimes amounting to complete fusion) of the trulleum with the tegumen and the general toughness of the connective membrane, the conclusion seems to be that the parts are designed less to guide or support the aedeagus than to hold the end of the abdomen in an exact position during copulation.

The other families of the Hepialoidea seem to the writer to be, on the whole, rather more specialised in the male genitalia than the group under notice, but in the absence of sufficient material of the Palaeosetidae and Prototheoridae for a full study a more definite opinion cannot be advanced.

2. The Male Genitalia of the New Zealand Species of Hepialidae.

As at present known, the New Zealand representatives of the family comprise one species of *Charagia* and nineteen of *Porina*. Several of the species, however, are very rare, or are represented by the type specimen only; I am therefore unable to include them in this investigation. As the general character of the genitalia has been fully gone into in the first part of this paper it is proposed in this section merely to make a few notes under the head of each species, trusting that the figures and key will fulfil the main purpose in view, that is, the identification of the species.

Charagia virescens, Dbld. (fig. 5).

Above the dorsal margin of the tegumen a triangular area of membrane has become slightly chitinised, and within this is a more strongly chitinised portion consisting of two arms springing from a central piece. It is possible that this represents either the rudiment or vestige of certain dorsal structures which, in some primitive groups, *i.e.*, PALAEOSETIDAE and PROTOTHEORIDAE, take the place of the uncus, or arise seemingly unconnected with the tegumen. The arms of the vinculum are very broad and the juxta departs from the narrow quadrangular shape of several Australian species which were available for examination.

Porina fusca, Philp. (fig. 16).

Trulleum a flat plate. Juxta quadrangular, broadest basally. Saccus shallow. This is one of the smallest species and the genitalia are smaller in proportion and not strongly chitinised.

P. minos, Huds. (fig. 17).

Tegumen without inner prongs. Eighth sternite with caudal angles produced. Vinculum simple.

P. characterifera, Walk. (fig. 18).

Tegumen with a pair of strong apical processes; margin of flanges strongly and irregularly dentate. Juxta 4-lobed. Trulleum fused with inner prongs of tegumen.

P. enysii, Butl. (fig. 19).

Genitalia proportionately small. Tegumen very broad on lower half. Saccus moderate. Arms of vinculum short.

P. cervinata, Walk. (fig. 22).

Tegumen broad; margin of flange smooth; inner prongs somewhat dentate. Juxta 4-lobed, broad basally. Vinculum moderate.

P. mimica, Philp. (fig. 21).

Tegumen with apical processes small. Juxta not strongly lobed. Trulleum shallow. Vinculum with arms bent inwards.

P. jocosa, Meyr. (fig. 20).

Tegumen with apical processes short and broad. Juxta deeply excavate apically.

P. umbraculata, Guen. (fig. 24).

Tegumen with apical processes broad and fairly long. Vinculum deep and narrow. Harpes broad basally.

P. copularis, Meyr. (fig. 23).

Tegumen with rounded prominences in place of apical processes; upper half of flange recurved. Juxta 4-lobed, equally wide at apex and base. Vinculum flat on base, sides of base compressed.

P. despecta, Walk. (fig. 25).

Tegumen similar to that of *copularis* but flange much less recurved. Juxta broad basally. Vinculum not laterally compressed near base.

P. signata, Walk. (fig. 26).

Tegumen very strongly chitinised, apical prominence rounded, small. Vinculum rather small, angular in outline.

P. dinodes, Meyr. (fig. 27).

Tegumen cup-shaped on upper half, the margins almost meeting; inner prongs long, tapering. Juxta longer than broad, constricted above middle. Harpes narrow, moderately long, bent. Saccus very large. This species differs much more from any of the others than they differ among themselves.

3. Key to the New Zealand Species of *Porina*, based on the Characters of the Male Genitalia.

1.	Harpes comparatively long, ventral margins more or less dentate .	*dinodes.*
	Harpes comparatively short, ventral margins not dentate	2.
2.	Base of vinculum rounded	3.
	,, ,, not rounded	10.
3.	Tegumen with inner prongs	4.
	,, without inner prongs	*minos.*
4.	Trulleum a flat plate or but slightly convex	5.
	,, normal, about half as deep as long	7.
5.	Apical processes of tegumen very small	*mimica.*
	,, ,, ,, well developed	6.
6.	,, ,, ,, broadly rounded	*fusca.*
	,, ,, ,, pointed	*characterifera.*
7.	Upper caudal margin of tegumen dentate	*enysii.*
	,, ,, ,, ,, not dentate	8.
8.	Apical processes of tegumen short	*jocosa.*
	,, ,, ,, moderate	9.
9.	Vinculum deep and rather narrow	*umbraculata.*
	,, broad, rounded	*cervinata.*
10.	Outer prongs (suspensorium) of tegumen rounded apically . . .	*signata.*
	Outer prongs of tegumen truncate	11.
11.	Upper half of margin of tegumen strongly recurved	*copularis.*
	,, ,, ,, ,, slightly recurved	*despecta.*

A. Philpott, del. *Vaus & Crampton, Ltd.*

THE MALE GENITALIA OF THE HEPIALIDAE.

A. Philpott, del. *Vaus & Crampton, Ltd.*

THE MALE GENITALIA OF THE HEPIALIDAE.

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THE MALE GENITALIA OF THE HEPIALIDAE.

Explanation of Plates I–III.

(Lettering: *a*, genitalia, lateral aspect; *ac*, genitalia, caudal aspect; *b*, tegumen, caudal aspect; *bl*, tegumen, lateral aspect; *c*, harpe, from within; *cb*, harpe, from beneath; *d*, vinculum; *e*, juxta; *f*, trulleum; *fd*, trulleum, dorsal aspect; *g*, eighth sternite; *h*, process of vinculum.)

Plate I.

Fig. 1. *Leto staceyi*, Scott.
2. *Charagia splendens*, Scott.
3. *C. astathes*, Turn.
4. *C. ramsayi*, Scott.
5. *C. virescens*, Dbld.
6. *Phassus malabaricus*, Mo.
7. *Sthenopis purpurescens*, Pack.
8. *S. thule*, Stkr.
9. *Oncopera epargyra*, Turn.
10. *Perissectis australasiae*, Don.

Plate II.

Fig. 11. *Trictena labyrinthica*, Don.
12. *Hectomanes bilineata*, Walk.
13. *H. crocea*, Luc.
14. *H. fusca*, Luc.
15. *H. polyspila*, Meyr.
16. *Porina fusca*, Philp.
17. *P. mimos*, Huds.
18. *P. characterifera*, Walk.
19. *P. enysii*, Butl.
20. *P. jocosa*, Meyr.

Plate III.

Fig. 21. *P. mimica*, Philp.
22. *P. cervinata*, Walk.
23. *P. copularis*, Meyr.
24. *P. umbraculata*, Guen.
25. *P. despecta*, Walk.
26. *P. signata*, Walk.
27. *P. dinodes*, Meyr.

AN AQUATIC LAMPYRID LARVA FROM S. CELEBES

By K. G. Blair.

[Read February 2nd, 1927.]

With One Text-figure.

The single larva forming the subject of this note was collected by Dr. Malcolm A. Smith at Djikoro, Bonthain, S. Celebes, in February 1925, in a mountain stream at an elevation of about 4000 feet. Four or five of them were seen, the points of light being visible on the stones at the bottom of about two feet depth of water; two were secured, but one has unfortunately been lost.

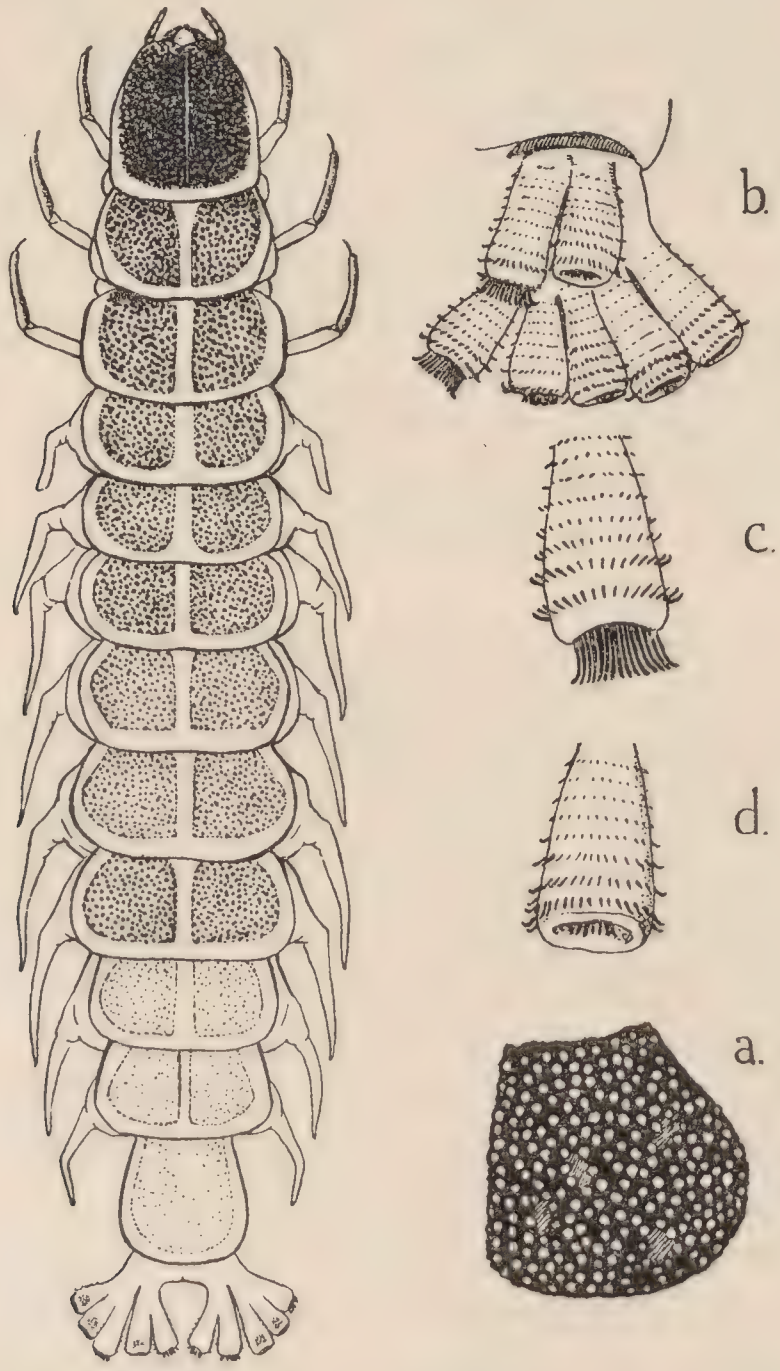

Fig. 1.—Aquatic larva of a Lampyrid (? *Pyrophanes*). *a*. Dorsal plate, 5th abdominal segment. *b*. Terminal grasping organ, ventral view. *c*. Single lobe of same with terminal hooks extruded. *d*. The same with terminal hooks retracted.

In appearance the larva (Fig. 1) is very like a partly grown larva of *Lampyris*, but with more feeble development of chitin. The body (in the preserved specimen) is white, with a membranous cuticle, the dorsal surface of each segment being protected by stouter plates, not quite covering the whole, and each divided medially. These plates are densely cribriform, with clear white pores or thin places; those of the thoracic and first six abdominal segments being black, while those of the last three abdominal segments are yellowish.

Small areas of the same yellowish colour are also found on the black plates of the more anterior segments. The head is almost completely retracted within the prothorax, but appears to be black and hard-shelled; it is provided with stout, sharply pointed jaws projecting forwards and meeting at the tips; the maxillae are apparently stout and well chitinised, and closely applied to the lower surface of the mandibles, but owing to the retraction of the head details of structure cannot be seen. The antennae are straight, the third joint long and slender, the fourth minute. The legs are well chitinised and of normal form. On each side of each abdominal segment from the first to the eighth is a tapering sac-like gill, those of the first and eighth segments being shorter than the others. Immediately above and a little forward of the base of each gill is a minute brown spot, apparently a functionless stigma. The ninth segment is narrower, a little longer than broad, its dorsal plate undivided, rounded behind. From beneath this segment project backwards two bundles of digitiform processes, each bundle being composed of five of these processes in a dorsal series, and two in a ventral series, each process being smooth and white above, but more corneous beneath with a series of transverse rows of hooks, and furnished at the extremity with a retractile group of larger hooks. These terminal groups of hooks when retracted are visible from above as a brown spot in the interior of the process just before the apex. This whole structure is obviously a modification of the terminal brush used by a *Lampyris* larva to clean its body from snail mucus after feeding, an adaptation as a grasping organ for holding on to the surface of stones, or the vegetation covering them, at the bottom of the stream. Definite luminous organs cannot now be localised, but Dr. Smith is of the opinion that in life the whole of the last three segments were luminous. It is probable that the larvae were feeding upon water-snails.

Aquatic Lampyrid larvae have already been described by the late Dr. Nelson Annandale, but these differ considerably from the subject of this note. One of them (*Proc. Zool. Soc. London*, 1900, p. 862) was found in some numbers in the Malay States beneath the surface of small stagnant pools, where the beetle larvae were found to be clinging, dorsal surface downwards, to the floating fronds of a small cryptogam. They only approached the surface at night, and captive specimens were always at the bottom of the water before morning. They were never observed to come to the surface to take in air, and no special respiratory organs were found. No part of the body was silvery in appearance under the water. The inference would seem to be that the necessary transfusion of gases in respiration took place through the general cuticle of the body, a condition of things not uncommon in aquatic larvae, *e.g.* in young Hydrocampidae (Lep.), in many Trichoptera, and some Diptera (*Corethra*, etc.).

Another aquatic larva belonging to the same family was subsequently found by Dr. Annandale to be not uncommon in Calcutta among the roots of a floating water-plant, *Pistia stratiotes* (*Jnl. Asiat. Soc. Bengal*, 1906, p. 106). Though the ordinary spiracles were undeveloped this species possessed a star-shaped funnel which could either be extended from the posterior extremity of the body or withdrawn into it, this funnel being connected with a couple of very bulky air tubes running along the sides of the body, and when in use thrust into the air beneath the leaves of the *Pistia*. This larva, which was considered to be that of some common fire-fly, possibly *Luciola vespertina*, was found to attack and devour water-snails, but attempts to rear it were not successful. Larvae that died when fully grown were found to be evidently about to undergo an ecdysis, with the body distended and full of eggs. Had

the larvae been provided with means of leaving the water and given opportunities of pupating, the question of their identity would probably have been solved.

Similar adaptation of the tracheal system to the requirements of aquatic life is of course very common in larvae of insects of various orders, *e.g.* Coleoptera (Dytiscidae, Hydrophilidae, Helodidae, *Donacia*, etc.), Diptera (Stratiomyidae, Culicidae, Psychodidae, etc.). Respiration by means of gills of various forms is found in Coleoptera (Gyrinidae), Neuroptera (*Sialis*, *Sisyra*), many Trichoptera, and in Odonata and Ephemeridae. It does, however, appear to be remarkable that these three principal modes of respiration in aquatic insect larvae should have been severally developed by the only three known aquatic larvae in the family Lampyridae.

As regards the Celebes specimen it is, I fear, impossible at present to assign it with certainty to any genus. The Lampyridae recorded from the island are few in number, apparently two species of *Luciola* and one of *Pyrophanes*. In addition there is in the British Museum a single male belonging to the genus *Colophotia*. This list, however, is no doubt far from complete. Of these both the genera last mentioned are of small extent, and both confined to Malaya and the East Indian Archipelago, and it is perhaps to one of these that the Celebes larva belongs rather than to the widely distributed and extensive genus *Luciola*. Of *Colophotia* the British Museum possesses a larva of *C. brevis*, E. Oliv. (hitherto undescribed but of which a description is given below), which presents certain points of resemblance to the Celebes larva, but on account of the difference in habits is scarcely likely to be congeneric. The early stages of *Pyrophanes* appear to be quite unknown, and it may be that our larva is that of *P. similis*, E. Oliv., described from Celebes.

Colophotia brevis, E. Oliv.

Larva white, cuticle feebly chitinised, the black dorsal shields not completely covering the body, and, except that of the ninth abdominal segment which is elongate and rounded behind, divided medially. Form slender, the pronotal shield being nearly twice as long as broad, emarginate in the middle in front at the end of the median division, and each half produced behind into two blunt lobes, this feature being repeated on each segment except the last. The first seven abdominal segments have each a median dark ventral plate, and small dark areas on the lateral fold, immediately beneath the spiracle. The eighth abdominal is completely pale beneath, and the paired dorsal plates abbreviated behind, this segment in life being evidently luminous. The ventral plate of the nearly tubular ninth segment is divided medially, and from the end protrudes the usual group of short white filaments forming the brush.

These larvae were found by Dr. Travers along the sides of wet ditches near Kuala Lumpur, the beetle being subsequently reared by him.

A PRELIMINARY ACCOUNT OF THE LIFE-HISTORY OF *COCCINELLA* 11-*PUNCTATA* (L.)

By O. A. Merritt Hawkes, B.Sc. (London), M.Sc. (Birmingham), and T. F. Marriner.

[Read March 2nd, 1927.]

Plate IV and Two Text-figures.

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1. Introduction.

C. 11-*punctata* has long been known, being first described in 1758 by Linnaeus. It has been studied by many collectors on account of its numerous aberrations, seventy being named (Donisthorpe), but its life-history has remained unknown.

There is an idea prevalent among collectors that *C.* 11-*punctata* chiefly inhabits areas near the seashore. It is frequently found on the marram grass (*Psamma arenaria*) which covers sand dunes, but it has also been taken in small numbers in inland situations. The largest numbers have so far been found by the seashore. Hawkes was told at Strasburg in 1923 that at times immense numbers of *C.* 11-*punctata* were found near the salt marshes of Lorraine, especially at Vic-sur-Seille and Marsal (Bourgeois), so their optimum condition may be found where salt is present in large quantities.

In August 1926 we found large numbers of this ladybird on Burgh Sands, which are flat meadows to the south of Solway Firth, three and a half miles north-west of Carlisle. Numbers of the insects were seen running about on dung-pads. Just inside the holes, many of which are made early in the history of a dung-pad by escaping gases, empty pupa-cases were found which were so fresh and unshrunken that the ladybirds had evidently just left them. Larvae, all in the last instar, were found either walking on the dung-pads or just inside the holes. No last-instar larvae were found deep in the pad, but considerable numbers of eggs were discovered attached to the top of the passages.

2. The Eggs.

The eggs are oval, yellow (a pale orange) and 2 mm. long. The eggshell is colourless, but owing to its irregular surface it refracts light and has the rainbow appearance of mother-of-pearl. The eggs are always the same colour, not having a range of shades like those of *A. bipunctata* (Hawkes, 1921). They are usually laid in the top of a passage not far from the surface, so that the ladybird does not penetrate deeply into the dung-pad. In one only of the nineteen batches of eggs discovered were they laid on the side of the passage. There is here a definite orientation, unknown as yet in any other Coccinellid. The eggs were laid close together; when they were removed the base of each was found to have been embedded in the manure in a round shallow pit.

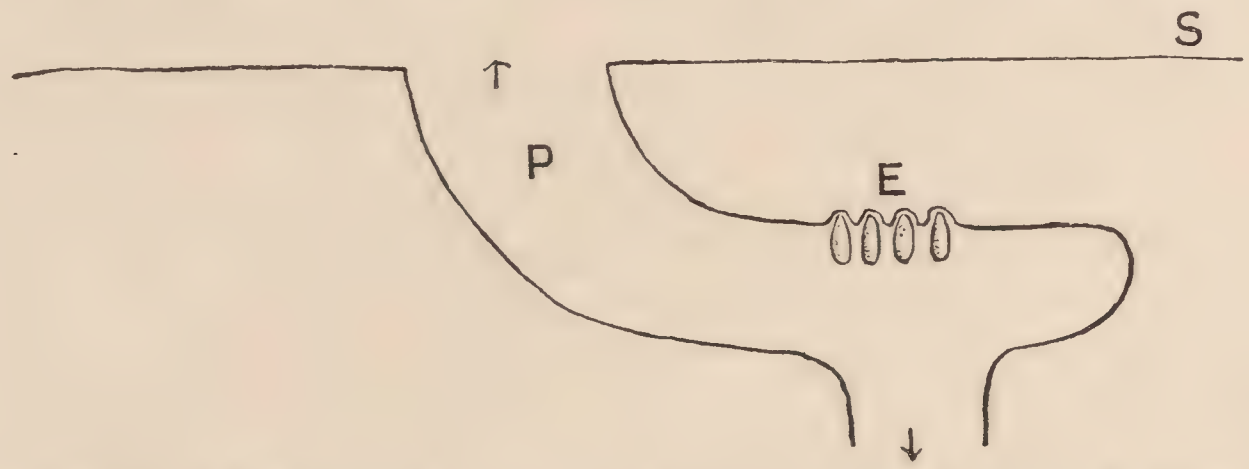
In order to discover if the ladybirds themselves ever made holes, pieces of

surface manure, with no holes, were placed in a glass dish, each piece being embedded in plasticine to prevent the ladybird from getting under the edge. But *C.* 11-*punctata* never made any holes. One female, immediately after copulation, went to the manure which had no holes, but ultimately laid a number of isolated eggs on the manure, on the surrounding plasticine and on the glass. The ladybird then generally turned round and immediately ate the egg she had laid. This eating of erratically deposited eggs has been observed by us in *A. bipunctata* and *C. septempunctata*, in the case of unfertilised females, but the behaviour in this case was probably due to lack of the right stimuli, negative heliotropism and an intense smell of dung (Richardson, 1925). One batch of twenty eggs laid on the manure was eaten, not by the parent but by other ladybirds confined in the glass dish.

Artificial holes were made in the manure and then nine eggs were laid in one; but it was found that the diameter had to be large enough for the ladybird to enter very easily.

Eggs were found in horse as well as cow dung; in the former there are no definite holes, but the texture after dropping soon becomes so loose that the ladybird can easily enter and find a suitable cavity for her eggs.

Twelve of the batches of eggs collected in August contained a total of 174



TEXT-FIG. 1.—Diagram of passage in manure showing eggs *in situ*. *S*, surface of manure; *P*, passage from surface down into manure; *E*, eggs.

eggs, eleven of which were discoloured and either swollen or collapsed. The eggs of all other ladybirds known to us are rarely discoloured.

We have exact data of the incubation period of only two batches of eggs. The eggs laid in the artificial hole hatched in four days and another batch in five days, the temperature of the room being in both cases 50 to 55° Fahrenheit. The incubation period would probably be shorter in an undisturbed pad with a temperature of 60 to 65° F. The anal temperature of cattle is between 101 and 102°, but the dropped dung quickly falls to 85° and then more slowly to lower temperatures. Subsequent fermentation and bacterial activity raise the temperature, which then remains comparatively steady for some days.

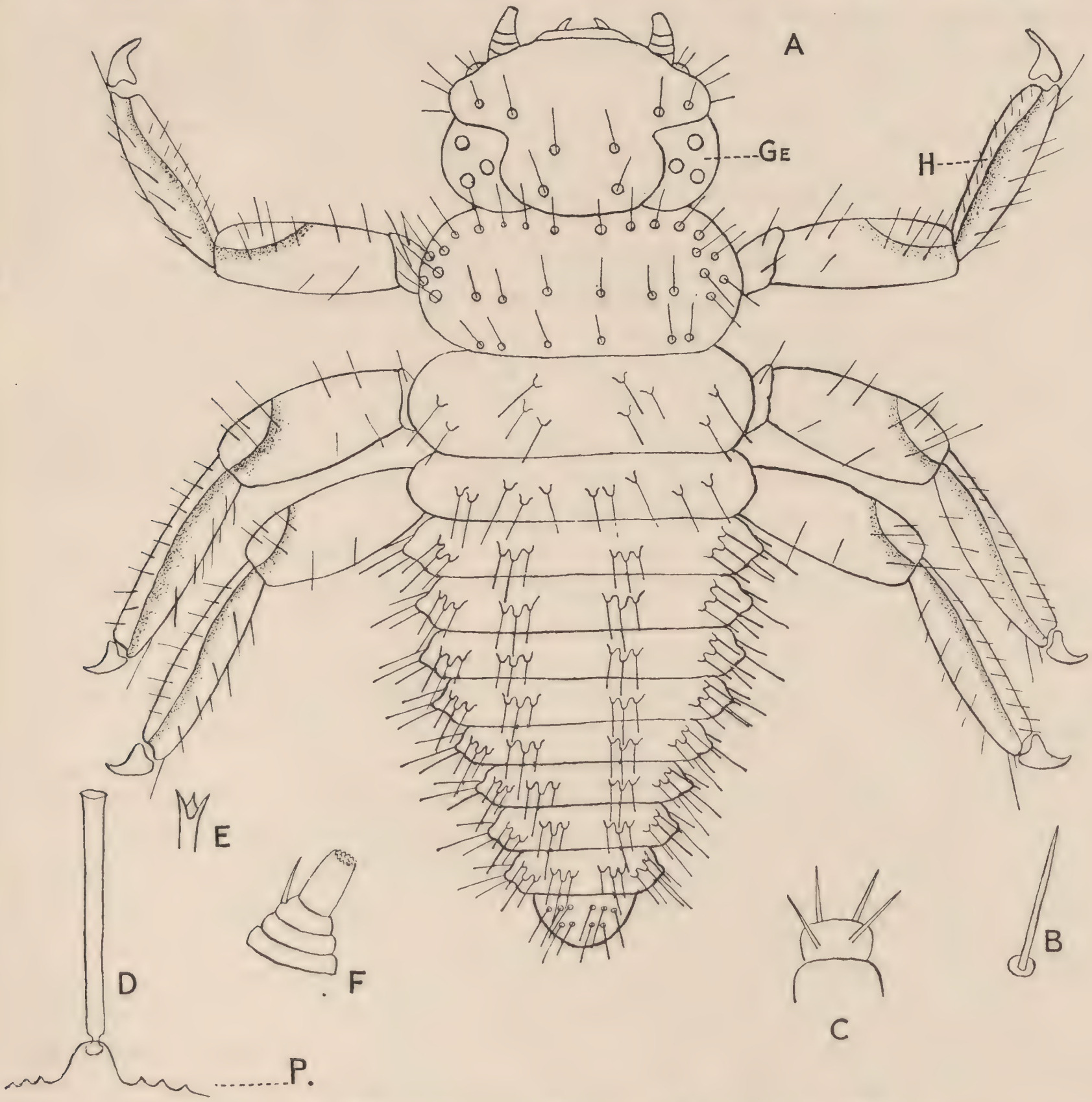
The eggs of *C.* 11-*punctata* are in a particularly sheltered position with a temperature steadier than is the case with any other Coccinellid we at present know, but the percentage of infertile eggs indicates some adverse factor which other ladybirds do not have to combat.

3. THE LARVA.

When the larvae were about to hatch the eggs were kept under constant observation.

The insect is pale yellow, except for a few black spots, when the shell first breaks. One larva was 1·7 mm. when it emerged five hours after the shell broke; it was then much darker, but the yellow yolk could be seen through the

transparent abdomen. The larvae did not appear to eat the eggshell, but soon separated and began to eat manure. There was no eating of the unhatched eggs and no early cannibalism such as occurs in *A. bipunctata* (Hawkes, Conquest; Marriner, 1926). Two-day old larvae at once made for a piece of fresh, moist, warm manure when placed in the box. Between the second and fifth days all the larvae had passed into the second instar. On the fifth and sixth



Text-fig. 2.—Diagrammatic drawing of first instar of larva.

A, the larva; *B*, pointed hair from leg; *C*, antenna, this usually has three joints, but paucity of material did not allow this to be determined with certainty; *D*, an obtuse hair from the abdomen with short processes (*P*) that cover all the body except the head; *E*, some of the hairs (*D*), end in points; *F*, maxillary palp; *Ge*, gena with three ocelli; *H*, the front part of leg is less deeply coloured and is very slightly concave.

days many of the larvae were dying or dead. The mortality in the boxes opened every day was so great that some boxes were placed in the dark, at a temperature of 60 to 65° F., where they passed through the following instars and pupated. The boxes were rarely opened and kept moist by pieces of saturated cotton-wool. We have seen the first, the second and the last instars, but we can at present only presume that there is a third instar as there is so great a difference between the second and the last.

The reaction of the larvae to light, sudden shadows and movements, is very different from that of other known Coccinellid larvae; for when the box is

shaken suddenly, their manure moved, or the shadow of a hand passed over them, the larvae of the first two instars curl up, roll over and appear dead, not for a second or two but for several minutes.

Certainly in the last instar and possibly in the third instar the reactions alter, the larvae become positively heliotropic and wander on to the surface of the manure. There and in the breeding-boxes they are not so deeply upset by movement, light and shadows.

In the first instar the larva becomes quite black. The legs are long. The thorax and abdomen are covered, but not thickly, with long hairs, the length of an abdominal segment, each attached to a knob-like base. The hairs increase in size and end, not in a point, but in a circular depression. The hairs on the head and legs are pointed and without the knob-like base. This instar lasted two or three days.

In the second instar the larva is black with light-coloured dorso-lateral and lateral tubercles on the first and fourth abdominal segments. This instar lasted four and five days respectively.

The duration of the presumed third instar is unknown.

In the fourth instar the larva (Plate IV) is a deep grey, almost black, with a grape-like bloom, the dorso-lateral and lateral tubercles on the first and fourth abdominal segments now being a pale orange. The two larvae pupated nine and ten days after the end of the second instar.

The larvae were seen to eat manure, but not to eat the two larvae of *Scymnus* (unknown species) found in the dung or the mites, fungi, worms, etc., which were so abundant.

Three references only to the larvae of *C.* 11-*punctata* have been found. Chitty (1893) says, "The larvae occurred on the salt marsh, under seaweed, rubbish, etc. . . . it is a puzzle to me what it usually feeds on." Donisthorpe (1903) writes about *C.* 11-*punctata* (adults, pupae and larvae) found on sand hills in Galway, "The larvae were feeding on an aphis on *Lotus corniculatus*." Lewcock (1892) states, "The experiment of trying to rear the larvae of *C.* 11-*punctata* on the garden aphides proved an utter failure. . . . I obtained a couple of starved specimens from about 50 or 60 larvae which I believe were nourished from the carcases of their companions."

The larval period of fifteen and nineteen days respectively is shorter than that found in *A. bipunctata* in England, minimum sixteen and maximum thirty-nine days (Hawkes, 1921), and *C.* 10-*punctata*, minimum seventeen and maximum thirty-three days. (Hawkes, unpublished.)

One larva pupated just inside a passage, another at the entrance and three on top of the manure.

4. The Pupa.

The pupa is a deep grey with a faint suggestion of orange spots on the dorsal side. It could not easily be distinguished from that of *A. bipunctata* or *H. variegata* (Goeze). The pupation period was seven and eight days respectively. As the pupae are outside the pad the time of pupation would vary, as in other species, with the temperature.

5. The Imago.

The two imagos appeared twenty-six and thirty-two days respectively after egg-laying. This period varied from twenty-eight to fifty-six days in *A. bipunctata* (Hawkes, 1921), and from forty-one to fifty-three days in *C.* 10-*punctata* (Hawkes, unpublished).

On emergence the elytra and wings are a light yellow, without spots, but as

is usual in the Coccinellids the pronotum has its full colour. At the end of two hours the spots had appeared and were distinctly black. In one specimen which had a deep colour on emergence the black spots could not be seen for four hours. Newly emerged *C.* 11-*punctata* were put in dark boxes and others in light, but there was no difference in the rate at which they attained the full adult colour, probably as in other Coleoptera (Gortner) the final colour is due to oxidation. About 2 per cent. of this species taken never become a bright red colour.

Very soon after emergence the ladybirds began to eat and mate. They chewed pieces of partly decayed straw in the manure, but we do not know whether they used the semi-liquid part. So far, they have not been seen to eat any of the fungi or animals in the manure. They ate split raisins with as great avidity as *A. bipunctata* (Hawkes, 1921), or *Hippodamia convergens* (Hawkes, 1926). They attacked the small green uncovered beech aphis, *Phyllaphis fagi* (Linn.) at the tail and ate them in from thirty-nine to forty-two seconds. We do not yet know what other aphids they will eat.

The males under observation apparently never went near the dung but ate the food provided, split raisins and beech aphis. The females were quickly attracted to a piece of moist manure. Richardson (1916) found that females of various insects were more attracted by ammonia than the males.

The imagines are more sensitive to the stimuli of movements and shadows than *A. bipunctata* and *C.* 10-*punctata*, and feign death for some time but not for so long as their larvae.

Copulation takes place in full light. It lasts for short periods, but is repeated frequently. Not in one case have we seen the long copulation characteristic of the commoner ladybirds.

In August 1926 eggs were laid soon after emergence. There are certainly two if not more generations during the summer. Theoretically this species should be abundant and widespread, for its food-supply is everywhere and continuous; but although it at times occurs in large numbers it is not as common as *A. bipunctata*, *C.* 10-*punctata* or *C. septempunctata*.

At the end of the summer the ladybirds sheltered at the roots of grass or under dried manure-pads, either solitary or in small groups. On sunny days they emerged and ran up the grass stalks, but there was no attempt at mating. The females appear to react to sunshine more quickly than the males.

If the ladybirds remain on Burgh Sands all the winter there must often be a great holocaust, as these meadows are frequently flooded. In August 1921 and 1926 large numbers of these ladybirds appeared on the Sands, but during both the preceding winters the meadows had *not* been flooded.

It is important to know whether *C.* 11-*punctata* occurs in larger numbers in cattle-breeding districts than elsewhere.

6. Enemies.

1. Some of the larvae died as a result of being attacked by the fly, *Phalacrotophora fasciata* (Fln.), whose cocoons were also found in the manure. How much damage is thus done is not known, but in 1921 Marriner lost nineteen larvae out of thirty larvae of other Coccinellid species.

2. *Aphodius punctato-sulcatus* bit one adult and one larva, both dying immediately, but we do not know if the ladybirds were subsequently eaten.

3. Black-headed gulls eat many of the insects in the dung-pads, and the elytra of this species have been found in their droppings.

4. An unknown fungus killed three larvae in the last instar.

We wish to thank Major E. E. Austen, D.S.O., for naming the emerged

parasitic fly; Dr. A. D. Imms for stating that the larva in fig. 2 (Plate IV) was attacked by fungoid growth; Mr. L. E. Hope, F.L.S., of Tullie House Museum, Carlisle, for making the microphotographs, and Mr. G. B. Routledge for help with the list of references.

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Explanation of Plate IV.

Larva of *Coccinella* 11-*punctata*.

Fig. 1. Microphotograph of last instar of larva.

2. Microphotograph of larva in last instar softened in 10 per cent. potash, the ventral side opened, the guts removed and the larva flattened. This shows the six dorsal tubercles in the first eight abdominal segments, and the fungal spores with developing hyphae, which are thickly but irregularly distributed and which probably killed this and two other larvae.

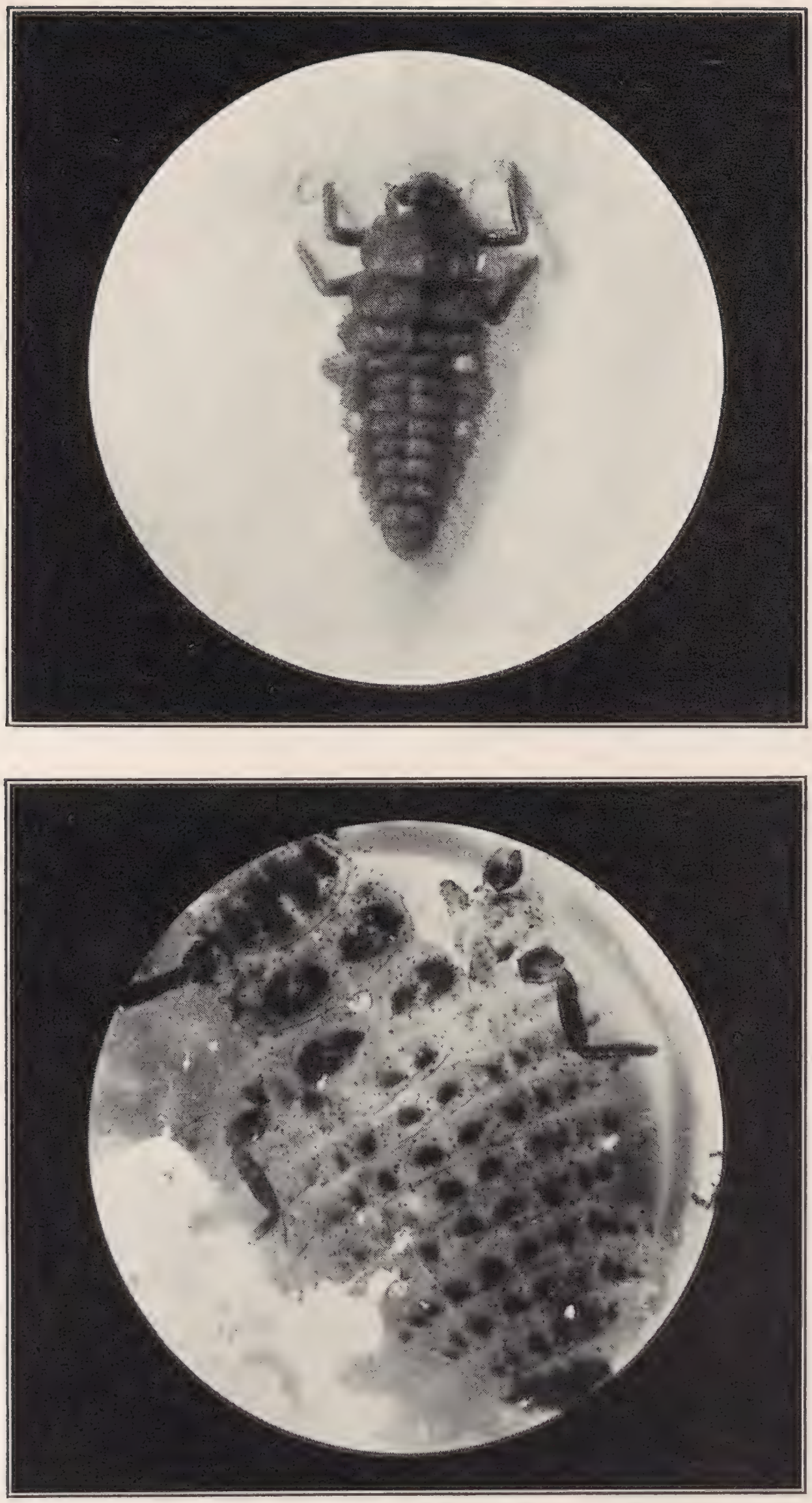

Photo by L. E. Hope. *Vaus & Crampton, Ltd.*

The larva of *Coccinella 11—punctata*.

STUDIES IN THE COPULATION AND OVIPOSITION OF *ANACRIDIUM AEGYPTIUM*, L. (ORTHOPTERA, ACRIDIDAE)

By S. M. Fedorov.

(From the Entomological Laboratory of the South-Crimean Station for Plant Protection.)

(Communicated by B. P. Uvarov.)

[Read March 2nd, 1927.]

Plates V–VIII.

The following accounts of the intimate processes of the sexual life of the Egyptian grasshopper represent a preliminary communication on the results of our studies of the general bionomics of that insect, both in nature under the conditions of the south coast of the Crimea, and in the laboratory. The publication of the complete results of our work is delayed for various reasons; the main one being that our original modest plan of investigations underwent considerable alteration and enlargement of scope, thanks to the kind interest taken in our work by Mr. B. P. Uvarov and Prof. V. F. Boldyrev. I express here my deep gratitude to both these gentlemen for their moral support and for their assistance with regard to literature.

I. Copulation.

Prof. V. F. Boldyrev in his work on spermatophores and copulation in *Locustodea* and *Gryllodea* (1914) expressed an opinion that some unexpected surprises may be discovered in the details of analogous processes in Acridodea.

Now we have, in the paper by Miss A. S. Iwanowa (1925), a description of the genital apparatus and some observations on the spermatophore-like bodies of the males of *Locusta migratoria*, L., while A. J. Sokolow has given (1926) a description of the female genital apparatus of the same species. The entire process of copulation and fertilisation, and the actual function of the various parts of the complicated genital apparatus in Orthoptera remain still practically unstudied. In our work on the bionomics of the Egyptian grasshopper we have, in fact, met some surprises in the processes of copulation which are worth the serious attention of zoologists.

Before describing the process of copulation in detail, it is necessary to describe the structure of the genitalia in both sexes of the insect under study.

The genital apparatus of the male Egyptian grasshopper consists of the following parts (Pl. V, fig. 1): *testes*, two *vasa deferentia*, a pair of *vesiculae seminales*, fifteen pairs of tube-like accessory glands and the *ductus ejaculatorius* with penis. The testes in our species are of a somewhat complicated structure. They are paired, but closely glued together and included within a common membrane, so that they look like an unpaired organ, and only the vasa deferentia enable one to distinguish the two parts. Each part consists of 150–200 separate spindle-shaped tubes—seminal follicles. The testes in the body of the grasshopper are placed in its abdominal region, occupying the 3rd, 4th and 5th segments; the tops of the follicles are directed upwards and the vasa deferentia downwards.

The vasa deferentia are like fine tubes, which begin from the anterior portion of the testes and run at first backwards and parallel to them; behind the testes they diverge a little and approach each other again just before entering the ejaculatory duct, where they are connected with a pair of tubes, each of them tightly coiled up in a small ball surrounded by orange-yellow fat tissue. This pair of tubes always contains sperm and consequently their function is that of seminal vesicles.

Four out of fifteen pairs of the accessory glands are of milky-white colour and their secretion is granular and fatty by nature, while the remaining eleven pairs are transparent and their secretion is hyalinous and slimy (Grassé, 1923).

The ejaculatory tract begins from the place where the vasa deferentia and the tubes join, and it runs backwards, at first like a straight and rather broad tube, then it enters the broad part (" the shell ") of the penis, where it makes a loop, afterwards entering the narrow part (" the lancette ") of the penis.

The genital organs of the male have been described by Chopard (1920). His fig. 134 represents the structure of the penis, but in a very diagrammatic way, the inner chitinous parts being, in fact, much more complicated. Our fig. 3 represents the genitalia at the moment of copulation, when the cerci clasp the abdomen of the female, while the penis projects from its hood-like membranes and emits a spermatophore-like body; fig. 2 represents the " shell " and the " lancette " of the penis, enlarged.

The female genital apparatus of the Egyptian grasshopper (Pl. V, figs. 4, 5, 6) consists of ovaria, two separate oviducts, one common oviduct and the receptaculum seminis which opens independently.

The ovaria belong to the pectinate type which is common to all Acridodea. They consist of two long calyces, which bear on their inner margin over 160 egg-tubes of panoistic type. The apex of each calyx is strongly sinuous and bears a tube-like appendix, the *boyau calicial* of French authors, which functions as a gland, its secretion being pale pink in colour and easily frothing. This secretion is made into froth already in the calyces, and it accompanies the eggs coming out of ovaries, and serves also as a material for the " stopper " of the egg-mass.

The calyces open into paired oviducts which soon afterwards form a common oviduct, opening on the inner side of the subgenital plate, a little below its centre.

The receptaculum seminis is a long sinuous tube, somewhat dilated at the base and ending in a small ball, densely enveloped by a covering membrane. The ball when uncoiled is found to consist of a long sinuous tube with a small branch. The outlet of the receptaculum is under the lower valves of the ovipositor.

The female genitalia have also been described by Chopard (*l. c.*), but his figures are very diagrammatic and do not give a proper idea of the position of the receptaculum seminis and its opening. In our figure (Pl. VI, fig. 7) the female genitalia are represented as viewed from behind; in it also the middle pair of valves of the ovipositor is figured. The function of this pair is still not sufficiently clear; according to our investigations they serve only for the firmer connection of the lower valves between themselves and with the upper pair of valves. When the middle valves are removed, the regularity of work of the lower valves is destroyed.

The process of copulation in the Egyptian grasshopper is very peculiar. We have been particularly interested in some of its details, namely, in the means

used by females for attracting males, in the courting, in the length of time of copulation and in the intimate processes of the latter.

Copulating pairs were first met with in autumn, on sunny days in November; subsequently they were observed again from the middle of April until July, when the males began to disappear gradually. Copulating pairs have been observed most often on the ground, seldom on the branches of trees. Copulation began usually in the morning, seldom at some other time of the day, when the female, after feeding on leaves of the trees, rested on branches or, more often, flew to the ground. In the former case, the female opened its wings and waved them for some time, while sitting, and this attracted the males sitting either on the same tree, or on others near by. In the second case, the flight of a female to the ground attracted the attention of males, several of which collected round it; one of them then jumped on the female, hastily adjusted itself and pushed others away by excited movements of its hind-legs (Plate VI, fig. 8). After some time, often considerable, the male placed itself on the female's back more firmly, holding by the first two pairs of legs, while the hind-legs remained unemployed, their tibiae pressed close under the femora and the tarsi under the tibiae. The front legs of the male clasped the pronotum of the female, their claws catching at the lower margin of the lateral pronotal lobes. The middle legs clasped the female under its wings, near the base of the hind-legs (Plate VI, fig. 10). Having established itself firmly, the male lowered and then twisted sideways its abdomen, putting forth its terminal segments. At this moment its cerci were raised, its subgenital plate bent far backwards, and its penis, protruded from its membranous hoods, felt its way between the lower valves of the ovipositor of the female. Then the male cerci clasped the subgenital plate of the female and the protruding penis entered between the lower valves of the ovipositor into the opening of the receptaculum seminis. After that, the subgenital plate of the male was pressed tightly to the valves of the ovipositor of the female, the valves fitting the marginal excisions of the subgenital plate, while the male cerci clasped still more tightly the subgenital plate of the female near its base, so that their ends nearly reached the corresponding tergite of the female (Plate VI, fig. 9).

The process of copulation in this species takes a long time. Copulating pairs usually remain together for not less than 18 hours, often as long as 24 hours, but sometimes even two or two and a half days. They are not easily frightened, and allow themselves to be handled. Some cases have been observed of the pairs remaining together for shorter periods, but the investigations showed that in all such cases there was no proper copulation, but only an attempt at it. In such cases the pairs separate when they are approached.

If the upper valves of the ovipositor are raised 4–6 hours after the beginning of the actual copulation, one may observe between the lower valves the beginning of the formation of the milky-white, jelly-like mass, which does not appear during the short false copulation. Towards the end of copulation the female begins to jerk its hind-legs, which were motionless before; this jerking is repeated more and more often and with growing energy, until, at last, the female succeeds in dislodging the male, which also becomes somewhat disturbed. This ends the copulation. The jelly-like mass between the lower valves of the ovipositor now becomes yellow in colour, harder and more brittle, and the female begins to lose it bit by bit. Soon only a few flakes remain, and after 5–8 hours all is lost and there remain none of the external traces of copulation, that enable one to recognise a fertilised female during the first few hours after copulation.

The hard yellowish mass, as observed just after copulation, has an irregular elongated spherical shape (Plate VI, fig. 12). In alcohol and, particularly, in clove oil it hardens very quickly, while in water it becomes soft and its structure can be studied. It consists of numerous vermiform bodies, glued together by a substance of jelly-like character. Each body is hyaline, the anterior end being broader than the posterior, the latter sometimes also slightly widening at the tip (Plate VI, fig. 13). The anterior, open end bears a short cylindrical appendix which easily breaks off, so that most of the bodies appear without the appendix. The shape of the bodies is somewhat variable, their length being about one millimetre.

An inner cavity can be distinguished and the whole structure has the appearance of a very simple receptacle serving for transferring the sperm. When taken out of the male's penis it has the same shape as described, but contains sperm which is exuded from its anterior broad end. There is no doubt that this structure is a spermatophore.

We found between the female ovipositor valves 6–30 empty spermatophores, the numbers 12 and 18 being encountered oftenest. The number of spermatophores is in direct proportion to the length of time of copulation: 18–24 hours' copulation corresponds to 6–12 spermatophores; copulation lasting 36 hours gives 18–24 spermatophores, and during 60 hours 30 spermatophores are produced. Separate spermatophores we used to find in the dilated part of the receptaculum of the female, and in the narrow part of the male penis, while between the valves of the female ovipositor they always form a group, which we believe to be characteristic of the whole subfamily CATANTOPINAE. According to Prof. V. F. Boldyrev, who has studied spermatophores in a large number of Acridodea and has seen some of our preparations of the Egyptian grasshopper, the spermatophore group of the latter is very peculiar and not found by him in any other group.

The observations described above permit us to draw some conclusions or, at least, to make suggestions.

Sperm is produced in the follicles of the testis, as described by Iwanowa for *Locusta*. The vasa deferentia, which in our species have no inflated ends (ampullae) as in *Locusta*, serve for conducting sperm into the pair of tubes corresponding to seminal vesicles where the sperm is preserved. The remaining four pairs of milky-white tubes, and eleven hyaline pairs, produce the secretion which is used as a material for the body of the spermatophore.

The process of formation of the spermatophore, or its moulding, according to our observations, which agree with those of Iwanowa, occurs in the very beginning of the ejaculatory duct, but we found the spermatophore here to be soft and not to have its final shape. Its definite vermiform shape is assumed in the terminal portion of the penis. We believe that the narrow part of the penis ("lancette") determines the length of the spermatophore; at any rate, in the Egyptian grasshopper the length of the spermatophore is equal to that of the "lancette." We have found spermatophores in that part during copulation already hardened up, while in other parts of the ejaculatory tract they were like long tubes and soft. We have never found in the ejaculatory tract spermatophores which have been prepared before the copulation, and we believe that they are all prepared during the copulation itself, which explains the length of period required for the latter. It may be stated that from an hour and a half to two hours are necessary for the formation of a spermatophore and its transfer from the male to the female. Spermatophores are transferred into the receptaculum of the female and they are always found there singly. Here

they are emptied of the sperm and then ejected out of the receptaculum. It may be remarked that the penis remains all the time during copulation firmly fixed in the beginning of the dilated part of the receptaculum, and the empty spermatophores come out of the latter through the interstice in the upper horn-like part of the penis. Spermatophores ejected from the receptaculum are always accompanied by a certain quantity of sperm. The formation of a group of empty spermatophores may be explained in this way: while not quite ejected they accumulate between the lower valves of the ovipositor and are glued together by sperm. After drying up, the group becomes brittle and falls to pieces, which one by one drop from the ovipositor.

II. Oviposition.

In literature there are descriptions of the oviposition in the Egyptian grasshopper by Fabre and by Grassé. The latter author even gives in his later paper (1924) a figure of an ovipositing female. There are also numerous descriptions and figures of oviposition in other Acridodea—in *Locusta migratoria* (Nikolsky), in *Schistocerca gregaria* (Künckel)—but they do not explain fully the true sequence of events during those moments of the process which occur in the ground, nor do they determine the function of various parts of the genital apparatus involved in the act. These considerations led us to a study of the process by more exact laboratory methods, not only in the field as has been done by others.*

The intimate processes of oviposition could be observed only in a specially constructed cage. Since the latter may be useful for laboratory studies of oviposition in other Acridodea, we think it useful to describe here its construction and to give figures (Plate VII, figs. 14, 15).

It consists of a small four-walled cage with two sides of wood and two of glass, the top and the bottom being also of wood. The height of the cage is 25–27 centimetres, length (of the glass walls) 15–16 cm., and the width (of the wooden walls) varying: in the upper half it is $3\frac{1}{2}$ cm., while the lower half is only 7 mm. wide, this being the diameter of the abdomen of a female grasshopper. Owing to the different width of the cage above and below, its glass walls are made of two panes each, the upper (in the broad part of the cage) and the lower (in the narrow part). One of the lower panes is made double as is shown in the figure. The intervals between the broad and the narrow parts are also covered by narrow strips of glass (*a* and *b* of fig. 14). The wooden parts of the cage are firmly nailed together; the narrow strips of glass just mentioned are fixed permanently into grooves in the wooden walls, while other panes are kept in place by narrow strips of tinned iron, so that each one of them may be taken away, when necessary, without any jerks. It is the lower panes which have to be moved most often, as all the panes of one side must be removed when a photograph is taken. Between the lower panes earth is placed and lightly pressed down; to approach the natural compactness, the earth must be slightly moistened and then dried a little.

The cage described enables one to investigate the underground processes of oviposition and the functions of various parts of the ovipositor, while it permits also experiments during the act, and photography.

Females ready for oviposition may be recognised by the volume of the abdomen. Besides, the females ready to oviposit change their place in the cages: while they usually kept in the upper parts, they now climb down to

* Nikolsky (1925) studied the oviposition of *Locusta migratoria* in special cages, but he did not describe them.

the ground. Just before the act, the ovipositor begins to make movements, as if attempting to dig. A female exhibiting such symptoms is placed in the special cage, described above, and fresh food is given to her. Whatever the initial position of the female in the special cage, she is compelled, when ovipositing, to place herself along the glass strips with the end of the abdomen touching the earth. This creates excellent conditions for making observations.

Before the beginning of oviposition the female rises high on the first two pairs of legs, slightly supporting herself by the hind pair as well, while the abdomen is arched with its end perpendicular to the surface of the soil (Plate VII, fig. 16). The lower and upper valves of the ovipositor begin to work rhythmically, now opening, now closing again. In this way a hole in the earth is made and the ovipositor gradually enters deeper and deeper into the earth, while the abdomen extends. The extension of the abdomen is due to the expansion of membranes between the 4th and 5th segments, also between the 5th and 6th and the 6th and 7th; partly between the 3rd and 4th, and 7th and 8th. Other terminal segments not only do not extend, but are even more closely approximated to each other than usual. The membrane between the 4th and 5th segments expands up to 2 cm., that between the 5th and 6th up to 3 cm., between the 6th and 7th up to 1–1½ cm., while the whole extended abdomen may reach the length of 9–10 cm., its normal length being about 3½ cm. While the abdomen sinks deeper and deeper into the earth, the valves of the ovipositor are working incessantly. To give the burrow a regular round shape, the female often contracts the abdomen and corrects the work already done by twisting the end of the abdomen, from the 6th segment onwards, through 90° now to the left, now to the right. Concurrently with the underground burrowing the body of the female is gradually lowered so that in the end it is firmly pressed against the surface of the earth, so that even the wings are somewhat spread out. The whole process of digging a hole in a suitable soil, without special obstacles, occupies 1–1½ hours.

Towards the end of the digging operation the intersegmental membranes become strongly extended (Plate VII, fig. 17) and transparent, so that the calyces of the ovaria, full of eggs, and the abdominal air-sacs become visible. Of the air-sacs in the Egyptian grasshopper one thoracic pair and the first seven abdominal pairs are those most developed. When the abdomen is fully extended it becomes obvious that the expansion is due to the air-sacs; one can see that the rhythmical movements of the abdomen, which apparently facilitate the work of the spiracles, result in the filling of the sacs with air, in their expansion and in the expansion of the abdomen. Movements of the head and of the mouth-parts, which are observed during the act, are probably connected with the pumping of air into the thoracic air-sacs, as well as into the alimentary tract in order to extend the latter in accordance with the expansion of the abdomen.

Muscles are mainly concentrated in the terminal part of the abdomen and their function is to move parts of the ovipositor, which works like a boring instrument. The whole complex work of digging may be analysed as consisting of the following simple movements : (1) putting valves of the ovipositor together, (2) a jerk downwards and (3) opening the valves; apart from that, the ovipositor is turned by muscles now to the left, now to the right. The middle valves of the ovipositor, which are much smaller than the upper and the lower ones, fit tightly into special slits in the lower valves and, being connected with strong muscles of the upper pair, they regulate and strengthen the movements of the lower valves. When they are removed, the lower pair work very feebly and

irregularly. The earth during digging is not thrown out, but merely compressed, which is particularly noticeable in cages.

When the hole is ready, the female interrupts her work for a very short time, and then, slightly lifting the end of her abdomen from the bottom of the hole and closing the ovipositor, begins to emit the foamy mass. At this moment the work of the "*boyau calicial*" giving out its secretion may be seen through the transparent intersegmental membranes of the abdomen. It may be observed also that the eggs, which collected in the calyces, begin to move into the oviducts.

During the actual oviposition the subgenital plate is closely pressed against the lower valves of the ovipositor, and the egg, enveloped in a thin foamy film, is deposited through the excision in the lower valves and the subapical excision of the upper ones. The valves retain the egg for a short time, then it is pushed into the hole (Plate VIII, fig. 20). The egg comes through the valves within 9–10 seconds; after each two eggs there is usually a short interval. All this time the valves of the ovipositor are now drawn in, now project again holding an egg. The eggs are laid one by one with their micropylar ends downwards.

The whole process of oviposition lasts about an hour; towards its end the female begins to emit only the foamy mass for the stopper. The process of making a stopper occupies a further hour. During it the valves of the ovipositor are incessantly drawn in and then protruded, which serves to beat the foam. The abdomen begins to contract from the beginning of the egg-laying and towards the end of the formation of the stopper it assumes its normal shape. The female, after filling the hole with the foamy mass, puts some of the latter on the top like a button, and retires, usually to feed.

The foamy mass of the stopper is at first pale pink in colour, resembling the beaten white of an egg, and has a characteristic smell of fungi. Gradually it dries up and becomes hard, assuming a greyish colour. This colour is partly due also to particles of dust and earth, which soon make the upper "button" almost indistinguishable from the general greyish surface of the soil.

The number of separate ovipositions, under the Crimean conditions, is usually three, and they are separated by periods of 10–20 days energetic feeding. The number of eggs in the first egg-pod reaches 120–160, in the second 80–100, and in the third 30–60.

A freshly laid egg-pod is very delicate and it is impossible to take it out of the ground without breaking it, but after two or three days it becomes harder and may be dug out with comparative ease. It is cylindrical, 9–9½ cm. long and is usually bow-shaped, the curve being directed backwards, in relation to the body of the female; in *Locusta migratoria* the curve is directed forwards. Obstacles in the stony soil very often alter the shape of egg-pods and cause considerable variations.

However densely the eggs are placed in an egg-pod, each one of them is always covered by a thin film of foamy material, soft at first and hardening up later. This material seems to preserve the egg from infection, since the eggs taken from egg-pods may be kept alive for a much longer period than the fully developed eggs taken out of the ovaries.

The above observations may be summed up as follows :—

1. The hole for the egg-pod is dug by the upper and the lower pair of valves of the ovipositor, but the latter pair work feebly and irregularly if the middle pair of small valves be removed.

2. Eggs and the foamy material pass through an excision between the lower

valves and then through that of the upper valves, the subgenital plate being firmly pressed against the lower valves. At the moment of oviposition, all the valves are put together and not opened, as has been figured by Künckel for *Schistocerca gregaria*, by Nikolsky for *Locusta migratoria* and by Fabre for *Anacridium aegyptium*.

3. The extension of the abdomen is due mainly to extension of the membranes between the 4–5th, 5–6th and 6–7th segments.

4. Air-sacs during the expansion of the abdomen are strongly inflated, while before it they are small. The air is pumped into them through the abdominal stigmata by rhythmic movements of the abdomen.

5. Inflation of the air-sacs is the cause of the expansion of the abdomen.

6. Swallowing of air by the insect, which is indicated by movements of its mouth-parts, serves mainly for expanding the alimentary tract in accordance with the extension of abdomen.

7. The eggs during oviposition are not in the egg-tubes, but already in the calyces, and their micropylar ends are directed downwards.

8. An egg is always covered with a thin film of foamy material, preserving it from external influences.

9. Eggs in the egg-pod are always placed with their micropylar ends downwards.

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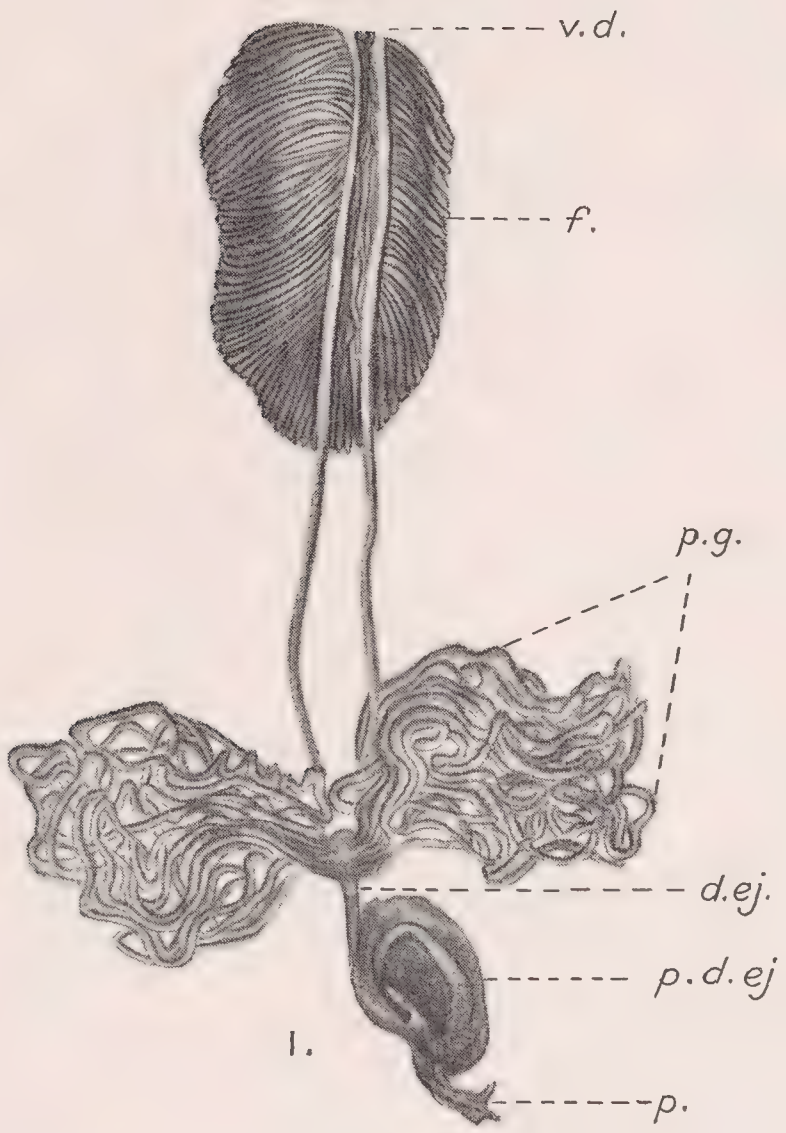

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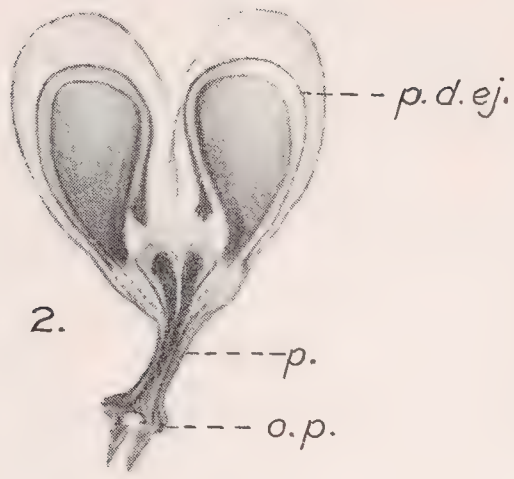

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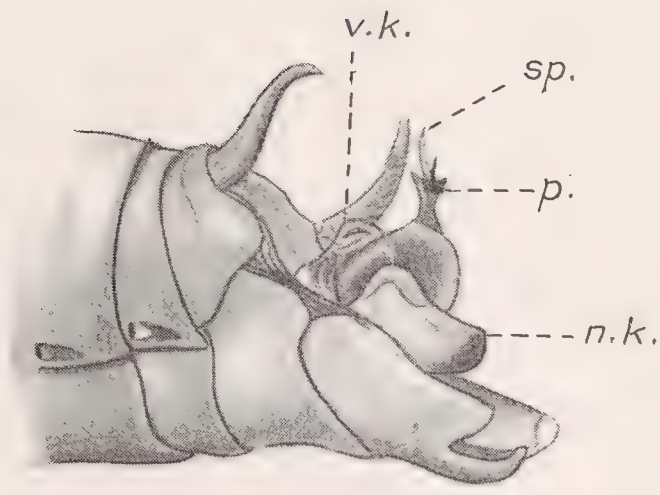

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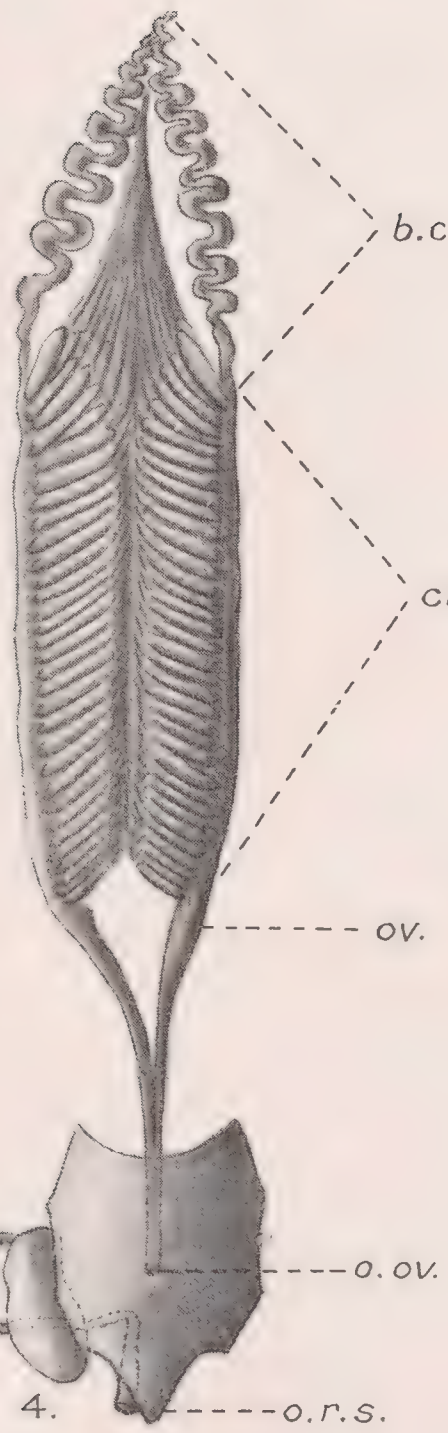

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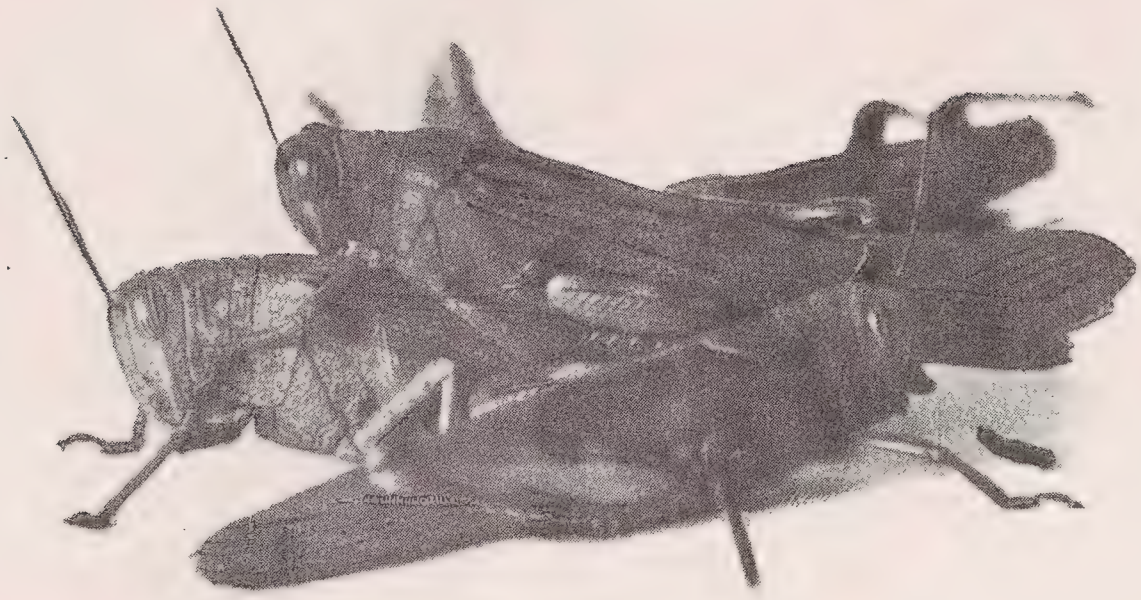

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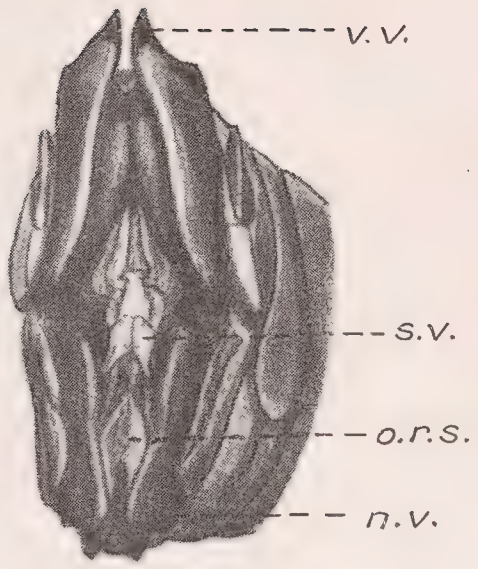

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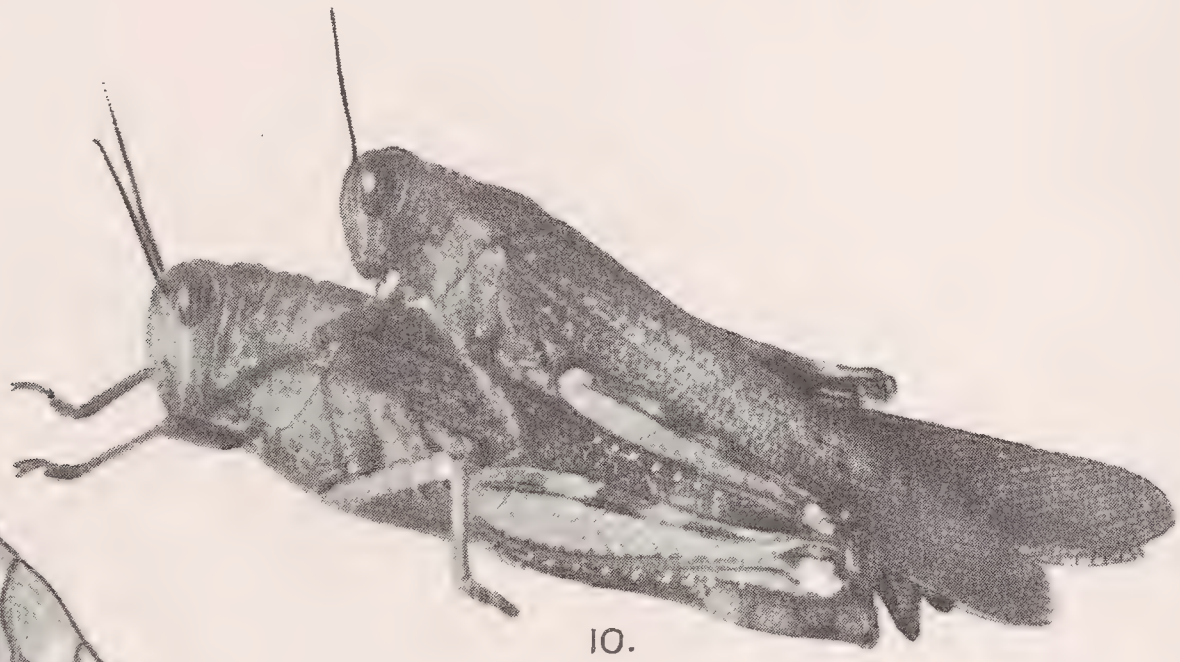

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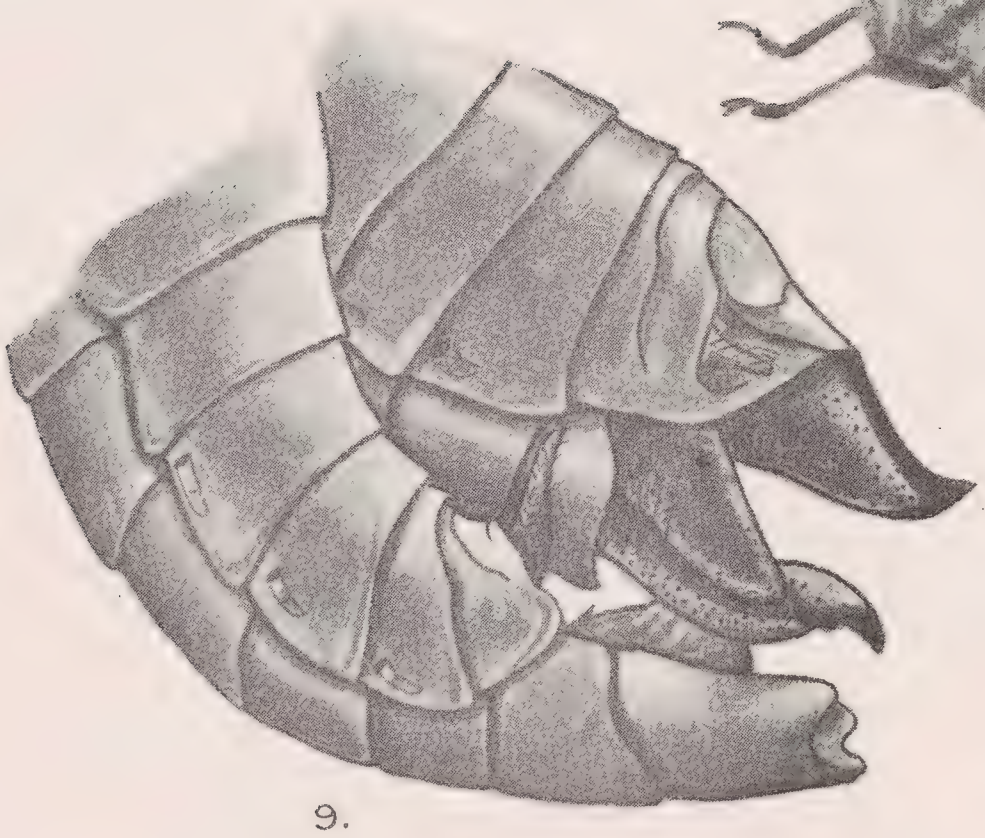

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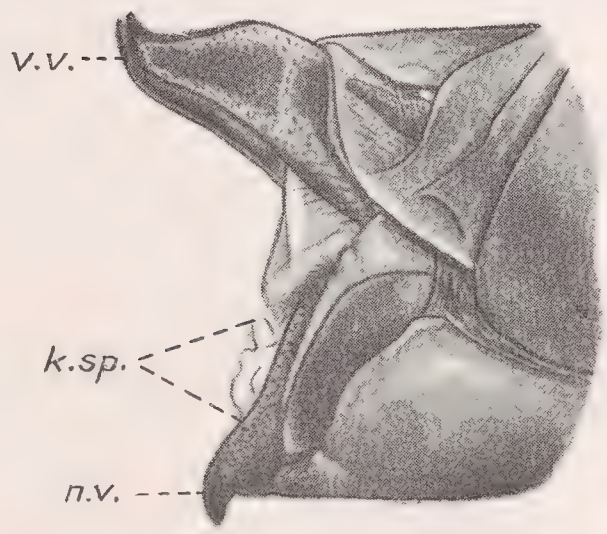

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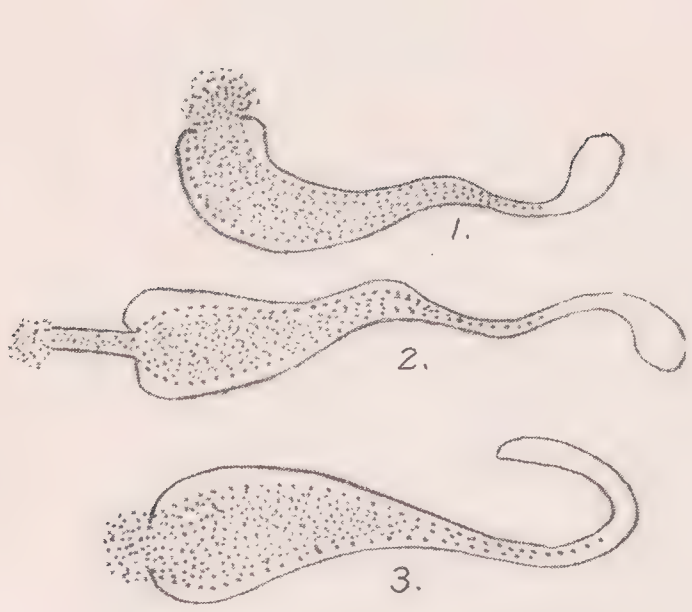

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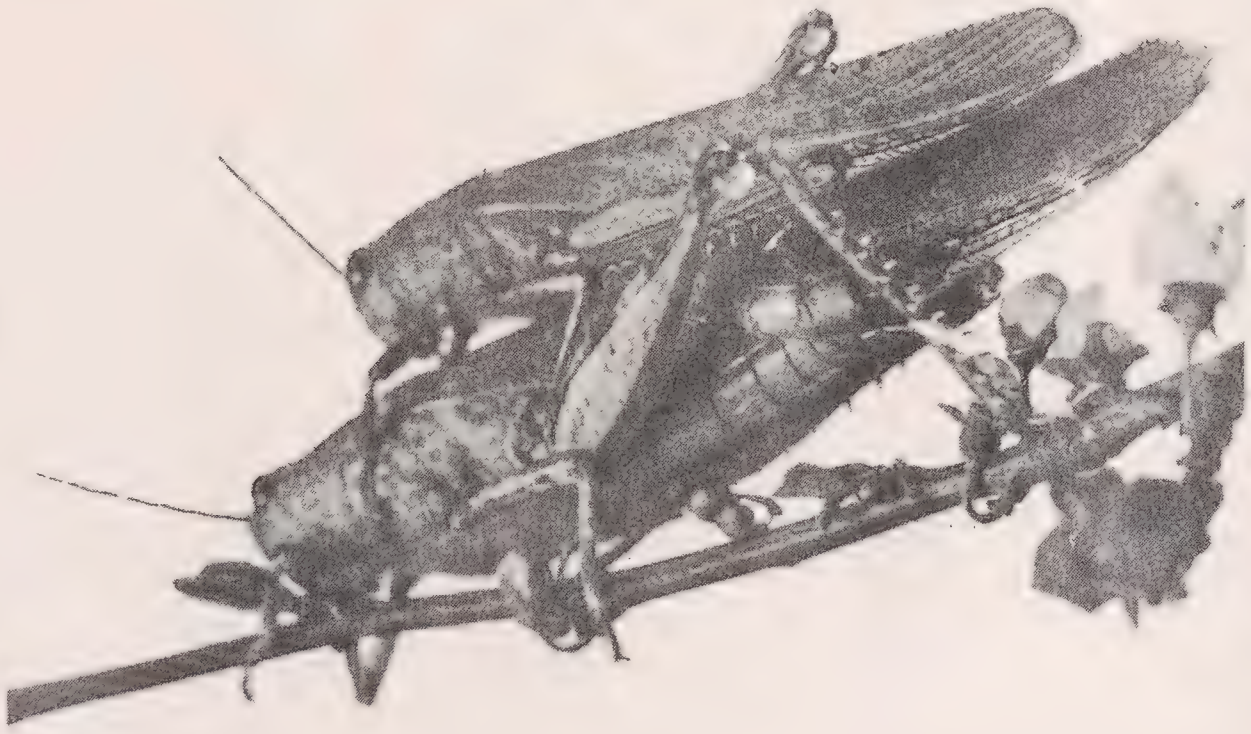

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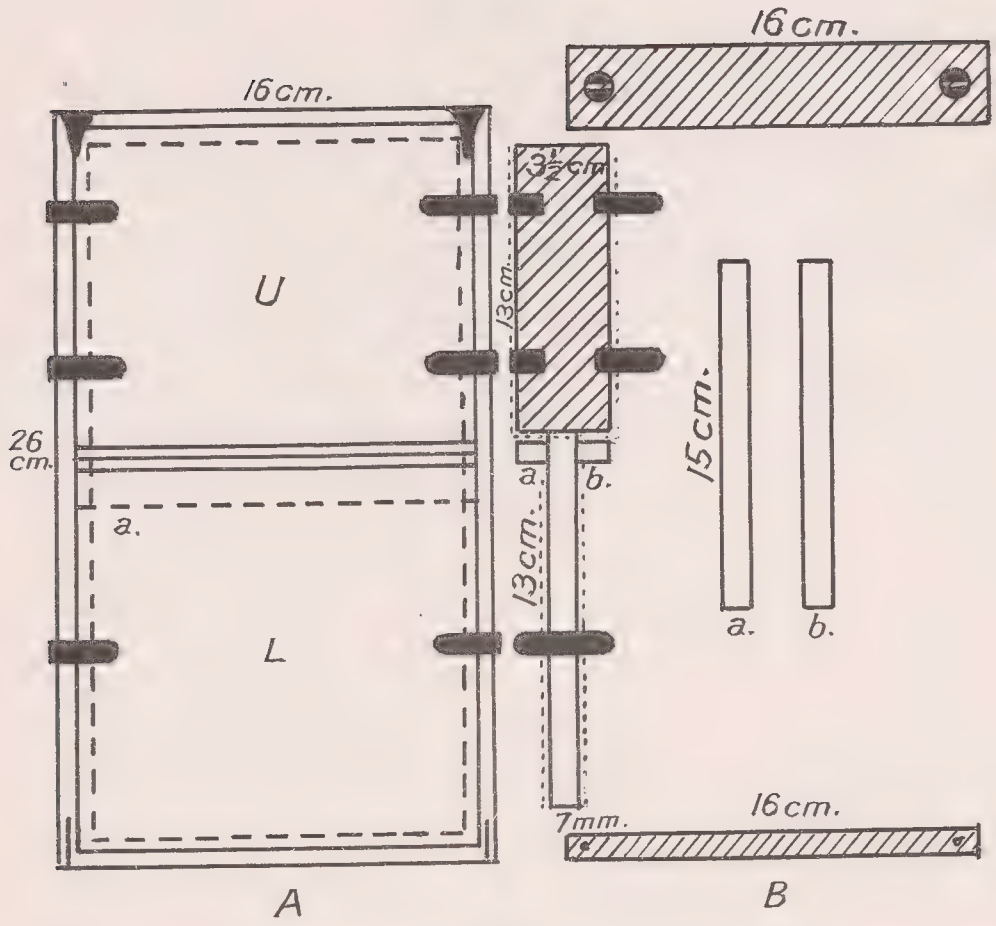

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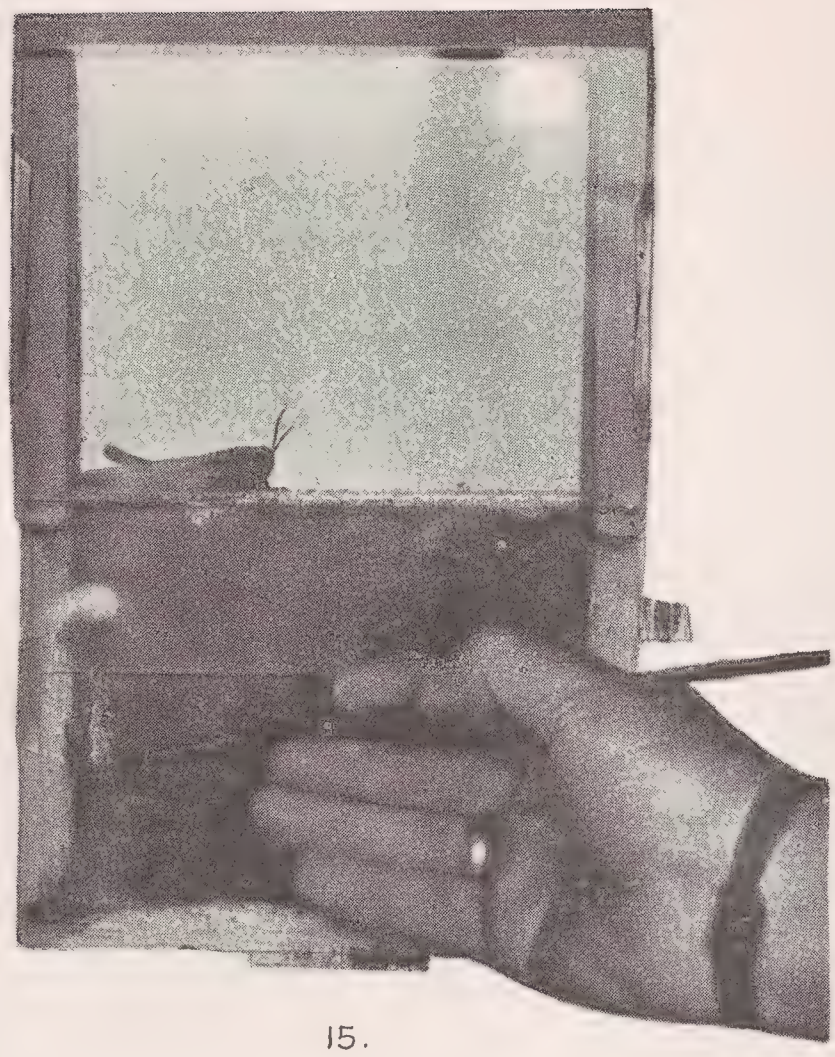

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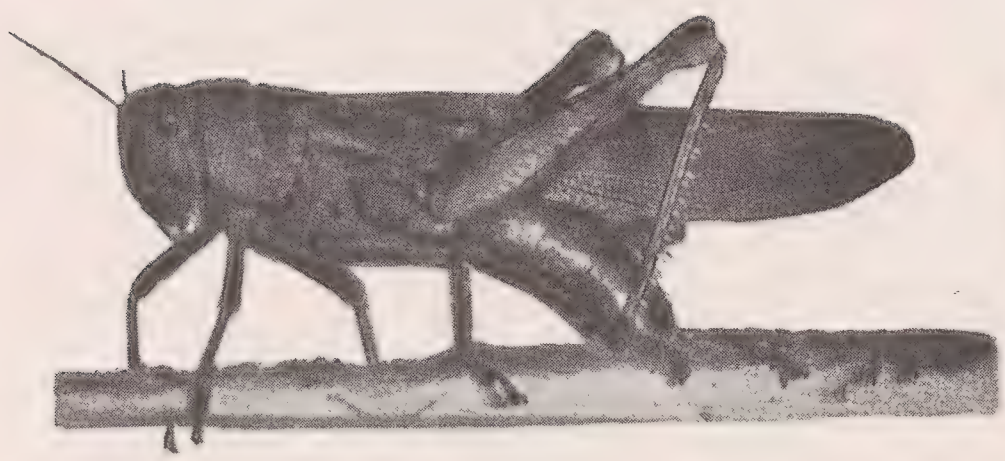

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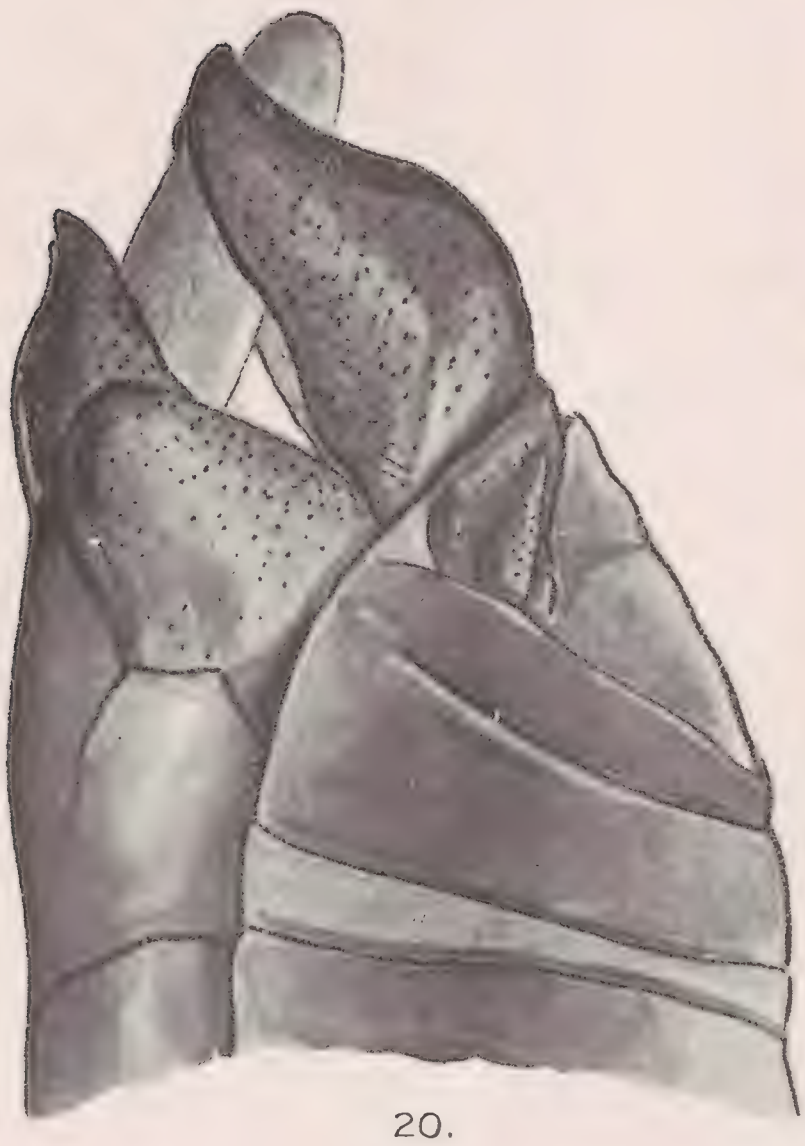

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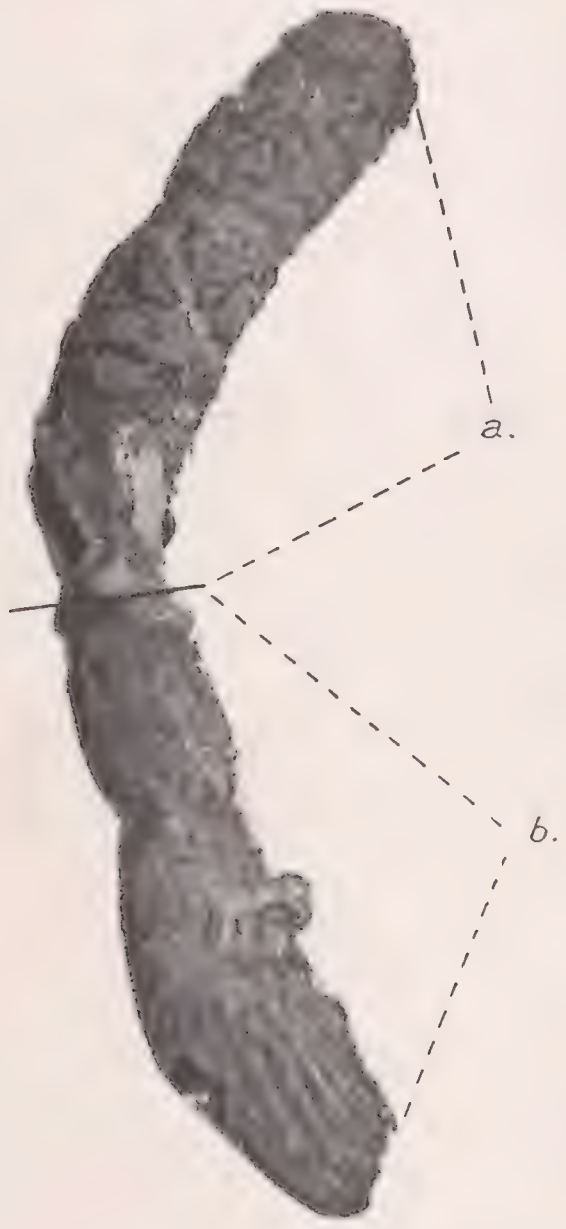

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John Bale, Sons & Danielsson, Ltd

OVIPOSITION AND COPULATION OF ANACRIDIUM AEGYPTIUM.

Explanation of Plates V–VIII.

Plate V.

Fig. 1. Male reproductive organs.
v.d., vas deferens; *f.*, folliculi; *p.g.*, glandulae accessoriae and vesicula seminales; *d.ej.*, ductus ejaculatorius; *p.d.ej.*, loop of the ductus ejaculatorius in the "shell" of penis; *p.*, penis.
2. Chitinous parts of penis.
p.d.ej., loop of the ductus ejaculatorius; *p.*, "lancette" of penis; *o.p.*, opening of penis.
3. Posterior end of the male abdomen during copulation.
vk., upper hood; *nk.*, lower hood; *p.*, penis; *sp.*, spermatophores.
4. Female reproductive organs.
b.c., "boyau calicial"; *ov.*, oviductus; *cal.*, calyces; *o.ov.*, ostium oviducti; *o.r.s.*, ostium receptaculi seminis.
5. Receptaculum seminis and lower pair of valves of ovipositor.
kl., the end ball of receptaculum; *o.r.s.*, ostium receptaculi seminis; *n.v.*, lower valvae.
6. Receptaculum seminis isolated.
v.r.s., upper section of receptaculum; *n.r.s.*, lower section of receptaculum; *r.r.s.*, dilated part of receptaculum.

Plate VI.

Fig. 7. End of female abdomen seen from behind.
v.v., upper valvae; *s.v.*, middle valvae; *n.v.*, lower valvae; *o.r.s.*, ostium receptaculi seminis.
8. Males courting a copulating female.
9. Ends of the male and the female abdomens at the beginning of copulation.
10. A pair copulating on the ground.
11. A pair copulating on a branch.
12. Ovipositor of female.
v.v., upper valvae; *n.v.*, lower valvae; *k.sp.*, an accumulation of empty spermatophores after copulation.
13. Spermatophores: 1 and 3 with the appendices broken off; 2, entire.

Plate VII.

Fig. 14. Cage for making observations on oviposition. A, side view; B, cross section; U, upper glass pane; L, lower glass pane; *a* and *b*, narrow glass strips. All measurements indicated on the figures.
15. Reduced photograph of the cage. Lower pane removed to make possible close observations, photography and experiments during oviposition.
16. Female beginning to burrow a hole for ovipositing.
17. Beginning of oviposition; abdomen fully extended.

Plate VIII.

Fig. 18. Oviposition; a few eggs are laid.
19. Oviposition; half of the eggs are laid.
20. An egg passing between the valves of ovipositor.
21. An egg-pod.
a, stopper; *b*, part containing eggs.

FURTHER NOTES ON *ANOMOSES* (LEPIDOPTERA HOMONEURA)

By A. Jefferis Turner, M.D.

[Read March 2nd, 1927.]

With Two Text-figures.

In the month of October, 1925, Mr. W. B. Barnard and myself, while camped in the Queensland National Park on the Macpherson Range at an altitude of 3000 ft., succeeded in obtaining a small series of *Anomoses hylecoetes*, Turn., comprising both sexes in much better condition and somewhat larger than the hitherto unique type. One specimen was disturbed by Mr. Barnard in the daytime; the remainder were taken by beating the edges of jungle tracks at night in the light of a petrol lamp. In this way they were easily captured, but we learnt nothing further of their habits.

I am now able to give a correct sketch of the neuration of this genus, that given formerly (1) being incomplete, and in one point inaccurate. It will be

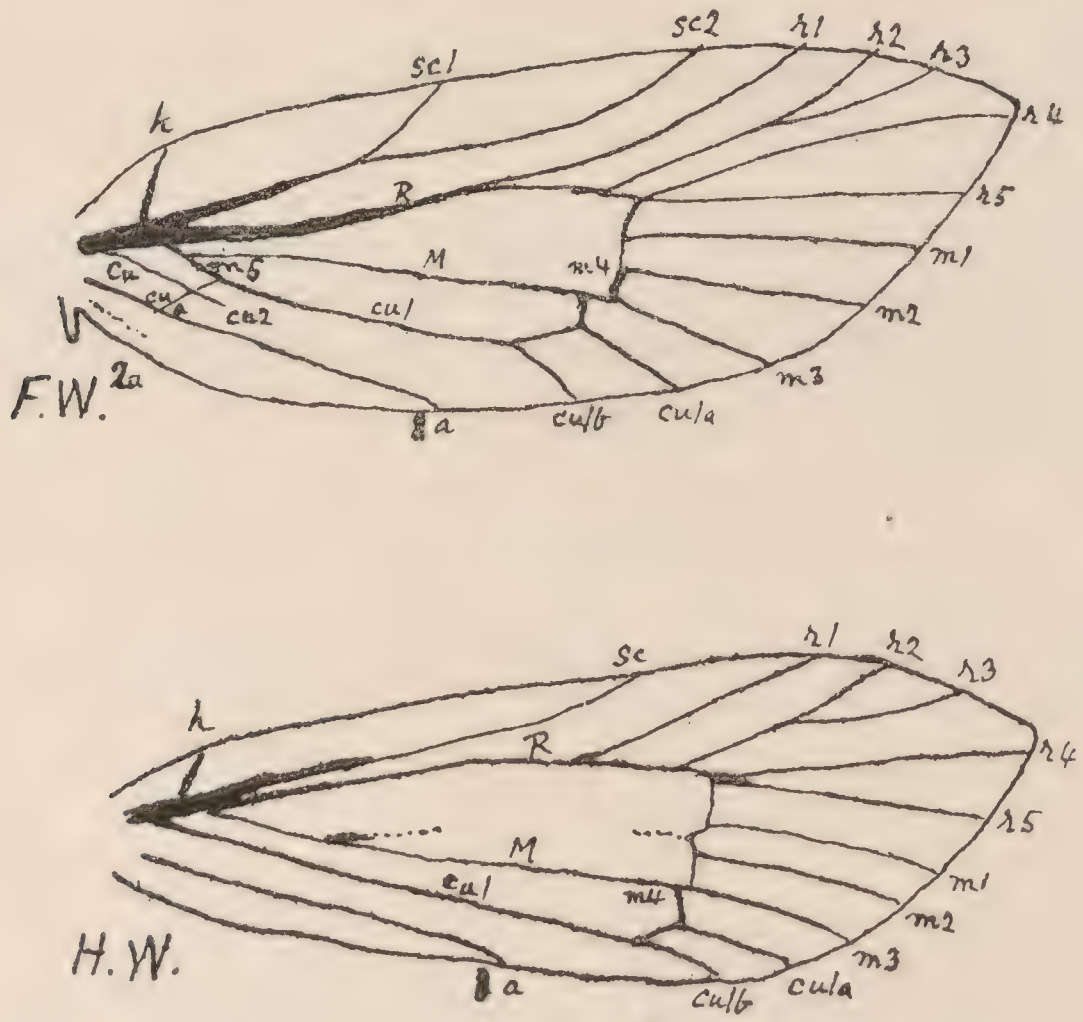

Fig. 1.—Neuration of *Anomoses hylecoetes*, Turn.

noted that the Subcosta gives off a strong humeral branch in both wings, and divides into *Sc*1 and *Sc*2 in the fore-wing only. The Radius is fused with the Subcosta basally; it gives rise to five branches, of which r^2 and r^3 are stalked, both running to the costa; r^4 and r^5 may be approximated, connate or stalked. The primary radial fork is beyond the middle of the cell. The Media arises from the Radius near its base and almost immediately gives off m^5 to join the cubitus. There is no median fork in the fore-wing, the upper primary branch of the Media being undeveloped. In the hind-wing the upper primary branch is present, but very imperfectly developed. The angle between m^4 and Cu^{1a} is obtuse (more than a right angle), contrasting with the acute angle (less than a right angle) in the Hepialidae and Prototheoridae, and intermediate between

the latter structure and that found in the Heteroneura. The basal part of the cubitus is weakly developed in the fore-wing, and Cu^2 is short and vestigial; the first Anal is present, together with the cubito-anal crossbar, and there is a slight vestige of a second Anal. These structures are exactly similar to those found in the HEPIALIDAE, and, as Philpott has shown (2) in the PALAEOSETIDAE. In the hind-wing there is only one Anal vein, and Cu^2 and *Cu-a* are absent. This neuration is hepialoid, the chief peculiarities being the obsolescence of the upper half of the median fork, most marked in the fore-wing, and some

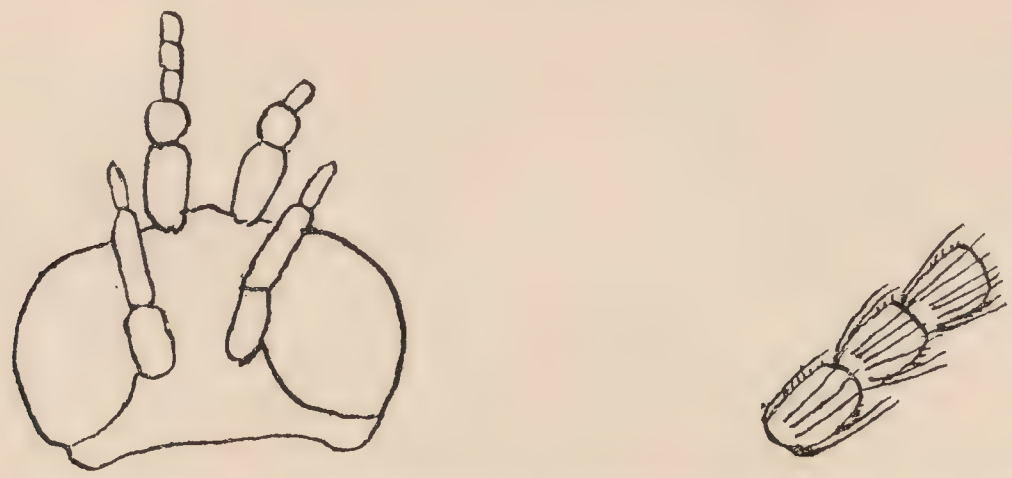

FIG. 2.—Head and palpus of *Anomoses hylecoetes*, Turn.

obsolescence in the anal area of the hind-wing, together with the obtuse angle between m^4 and Cu^{1a}.

A microscope slide of the head after treatment with liquor potassae shows large compound eyes and antennae, three-jointed labial palpi, no maxillary palpi, and no mandibles.

The ANOMOSETIDAE should, I consider, be retained as a distinct family intermediate in structure between the PALAEOSETIDAE and HEPIALIDAE. They are less closely allied to the PROTOTHEORIDAE, though they have one point in common, the presence of tibial spurs.

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1. TURNER. Trans. Ent. Soc., 1922, p. 600.
2. TILLYARD. Insects of Australia and New Zealand, p. 414.

THE LIQUID-SQUIRTING HABIT OF ORIENTAL GRASSHOPPERS

By Major R. W. G. Hingston, I.M.S.

[Read March 2nd, 1927.]

Plate IX.

This paper consists of field observations on the liquid-squirting habit of grasshoppers. Four species have come under my notice. These have been identified by Mr. B. P. Uvarov, to whom I am indebted for much assistance and advice.

1. **Poecilocerus pictus**, Fabr.

Habits.—This large grasshopper is one of the most striking insects on the plains of India. It is very conspicuous, brilliantly coloured, and feeds exposed on the leaves of the Ak (*Calotropis gigantea*). Its bright colour suggests a warning coloration, and makes one believe that it must be nauseous to birds. Both the young and the mature insect eject fluid. The method, however, differs in each. In the young the discharge is dorsal, in the adult lateral, the difference being correlated with the growth of the grasshopper's wings.

Emission of fluid.—(*a*) Immature form.—The immature grasshopper is very conspicuous. When half-grown it is greenish-yellow in colour, with delicate black markings and small crimson spots. At this stage the ejection is easily studied. The point of exit is on the dorsal surface of the abdomen in the cleft between the first and second segments. At the moment of discharge a jet is shot forth, sharp and sudden, sometimes to a distance of two inches or more. At other times the discharge is a steady stream. The exuded fluid is pale and milky, slightly viscid and unpleasant to the taste. The discharge may be repeated a number of times.

The grasshopper is able to direct its jet. If its head be pinched between the fingers, its back bends a little; this opens the slit, and the jet is shot forward on the observer's hand. If the end of the abdomen be pinched, the same action follows, but the jet is turned in the opposite direction. The employment of the jet, therefore, seems to be under the insect's control.

(*b*) Adult form.—The mature grasshopper is more gorgeously coloured. Its tegmina are green, spotted with yellow, hind-wings pale vermilion, body striped with canary yellow and turquoise. Since the tegmina now cover the dorsal surface of the abdomen, the aperture of exit for the fluid is concealed and the jet-like discharge no longer takes place. The fluid now oozes out beneath the lower margin of the wings and accumulates in a heap of viscid bubbles that project outward from either side.

Use of fluid.—In this species the fluid must be protective. It is certainly unpleasant. It comes out independently of pressure, can be turned in different directions, and is under the insect's control. Grasshoppers, as a rule, harmonize with their environment. But this species is conspicuous and brilliantly coloured. It lives freely exposed on the vegetation. It is fat and fleshy and unusually helpless, disinclined to fly, and making only ineffective leaps. Under such conditions it could scarcely survive unless it were unpalatable to birds.

2. **Typhoptera donovani,** Don.

Habits.—This species is large and conspicuous, black in colour, with lemon-yellow patches on thorax and tegmina. It is common at Jhansi throughout August, where it frequents the hedges of cactus. It is a heavy, sluggish, somewhat helpless insect, escaping danger by dropping into the cactus, and reluctantly taking to flight. Its haunts shield it to some extent, for it sits on a leaf in the midst of long thorns, which latter must protect it from birds. The thorns also are a source of danger, for they tear the grasshopper's wings to shreds. It sits still by day. By night it is more active, feeding on the cactus, and moving about amongst the thorns. Its resting attitude is unusual. The front-legs are pushed forward parallel to one another; between them are stretched the long antennae, brought close together side by side and pressed down upon the leaf.

Emission of fluid.—In this species fluid is discharged from the following points.

(1) From a pair of slit-like openings on the dorsal surface of the meso-thorax. When the thorax is compressed a jet of yellow fluid is shot out from these apertures. The fluid is slimy, not unlike the yolk of egg. Often it comes out in a regular spout to a distance of three or four inches. One aperture may discharge at the first compression, and the opposite aperture after a second pinch. On other occasions there is no jet. The fluid then comes out in a gentle oozing; or perhaps only a drop appears. The discharge seems to take place only as a result of mechanical pressure.

(2) From the base of the hind-legs at the membrane between the coxa and femur. There is no force behind this emission. The discharge is a simple oozing which smears the sides of the grasshopper and objects touching it with a yellow slime.

(3) From the tips of the tarsi of the front-legs. A gentle oozing may take place from this point which accumulates into a large drop. There must be channels running down the fore-legs by which this fluid is conveyed to their tips. One grasshopper was found with its front-leg broken off, and fluid was oozing from the amputated stump.

(4) From the base of the middle-leg at the membrane between the coxa and femur. A slight oozing may sometimes be seen at this point.

(5) From the tips of the tarsi of the middle-legs. A small drop is sometimes emitted from this point.

(6) From the tips of the tarsi of the hind-legs. A slight oozing.

(7) From the nervures of the tegmina. When the grasshopper's wings are pinched between the forefinger and thumb an oozing takes place from the nervures of the tegmina which covers the wings and fingers with slime. This oozing seems to be the result of direct pressure, since it takes place only from the part of the tegmina compressed.

3. **Aularches miliaris,** L.

Habits.—I found this species at Akyab on the coast of Burmah. They are plentiful in October, collecting in swarms on the bushes and grass where they mate and deposit eggs. It is a large, highly coloured, sluggish insect, exposing itself freely on the trees. When alarmed, it scarcely attempts to escape, being so heavy that it can make only a short leap. Its pattern of coloration is very striking; head and thorax dark green with a broad canary-yellow lateral band; tegmina green spotted with yellow; legs blue; hind-femora with a yellow serrated pattern; abdomen black banded with bright red. When

taken between the fingers this grasshopper makes a distinct noise. The noise comes from the thoracic segments. It is possibly the pronotum which takes part in its production; but, unfortunately, in the field, the exact apparatus was not observed. The noise is a rasping sound, not loud but sharp, and is probably an alarm note. It occurs only when the insect is irritated. It is probably protective, not a sex call as in *Typhoptera*, since both sexes equally produce the sound.

Emission of fluid.—Pressure is required in order to demonstrate the expulsion of fluid. If the grasshopper's thorax be compressed fluid exudes from the following points.

(1) From a pair of openings on the pronotum, one on either side of the median line.

(2) From two pairs of openings on the posterior margin of the metanotum, a pair on either side of the median line.

(3) From a single opening on each side of the thorax close to the base of the front-leg.

(4) From a single opening on each side of the thorax close to the base of the hind-leg.

Through these ten apertures fluid may exude when the thorax is pinched. It comes out from the thorax in a forcible jet. The fluid is usually clear as water; sometimes it may be turbid or faint yellow, but never like the yolk-of-egg effusion of *Typhoptera*. It is slimy, of a mucus consistency, faintly alkaline, with an unpleasant smell and a bitter taste. Air is emitted with the fluid. This leads to the formation of bubbles which give the discharge a frothy appearance and make it accumulate in heaps. A considerable quantity can be squeezed out, a teaspoonful at least. The piles of bubbles become as large as marbles and sufficiently copious to cover the thorax. The actual fluid is probably little in amount, most of the discharge consisting of air.

I tried if heat or chemicals had any influence on the discharge. Heat had no effect; nor had chloroform, nor cyanide of potassium. Methylated spirit vapour caused a black vomit, but no emission from the thoracic pores. Pressure, so far as I know, is the only cause that brings out the froth.

Use of fluid.—Has this fluid a protective function? It certainly is an offensive substance. Its association with bright colour and a chirping noise must also be of some significance. The bright colour is probably warning. If the grasshopper is taken in a bird's beak, the first thing that must happen is a rasping note. This may be sufficient to frighten the enemy and cause the morsel to be dropped. But if the bird persists and closes its beak then bubbles will exude from the pressure of its mandibles and the nauseous morsel will be cast out. The discharge of fluid is very wasteful, and is probably employed only as a last resort.

4. **Tegra novae-hollandiae,** Haan.

Habits.—This species differs markedly from the previous examples in being inconspicuous and protectively coloured. It is a large long-horned grasshopper frequenting the bark of the trees, where it blends perfectly with its environment. Its mottled colour and motionless attitude, with legs and antennae thrust out in front, make it very difficult to see. There are even spots of green on the elytra which might be thought to resemble the moss on the bark.

Emission of fluid.—Like *Aularches miliaris* it exudes a yolk-coloured fluid, so far as I have observed, only under pressure. The exudation comes out from the following points.

(1) From a pair of apertures, each in the centre of a green spot, on the dorsal surface of the pronotum. A large bubble of yellow fluid appears at each aperture when the thorax is laterally compressed. Pressure is necessary to produce the discharge.

(2) From the base of the hind-leg at the membrane between the coxa and the femur. A slight pressure on the thorax is sufficient to make the exudation appear at this point.

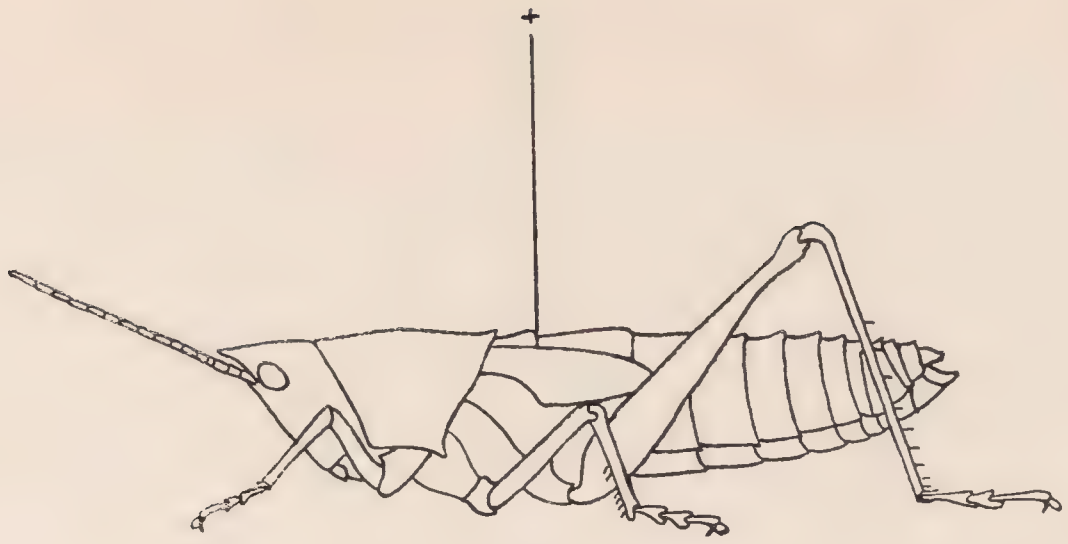
(3) From the nervures of the tegmina. When the tegmina are compressed between the finger and thumb fluid oozes out between them, presumably coming from the nervures.

Use of fluid.—The previous examples, being protectively coloured, and *Aularches* possessing an alarm note, suggested that the liquid-squirting habit had a protective significance. But in this example we have a liquid-squirting grasshopper which is as perfect an example of protective coloration as one could find anywhere in the group. It may seem superfluous that so well-concealed an insect should have this additional method of defence.

Explanation of Plate IX.

The liquid-squirting habit of Oriental Grasshoppers. Figures showing points from which fluid exudes.

Fig. 1. *Poecilocerus pictus*, Fabr. Nymph.
2. *Typhoptera donovani*, Don.
3. *Aularches miliaris*, L.
4. *Tegra novae-hollandiae*, Haan.



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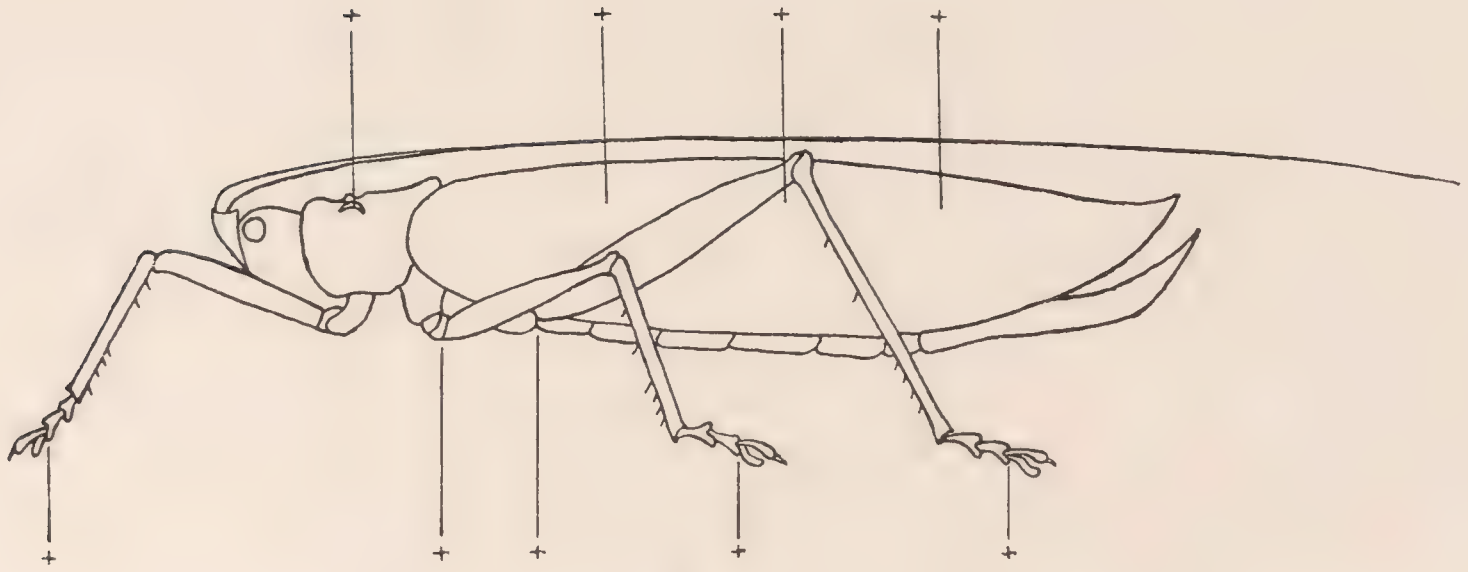

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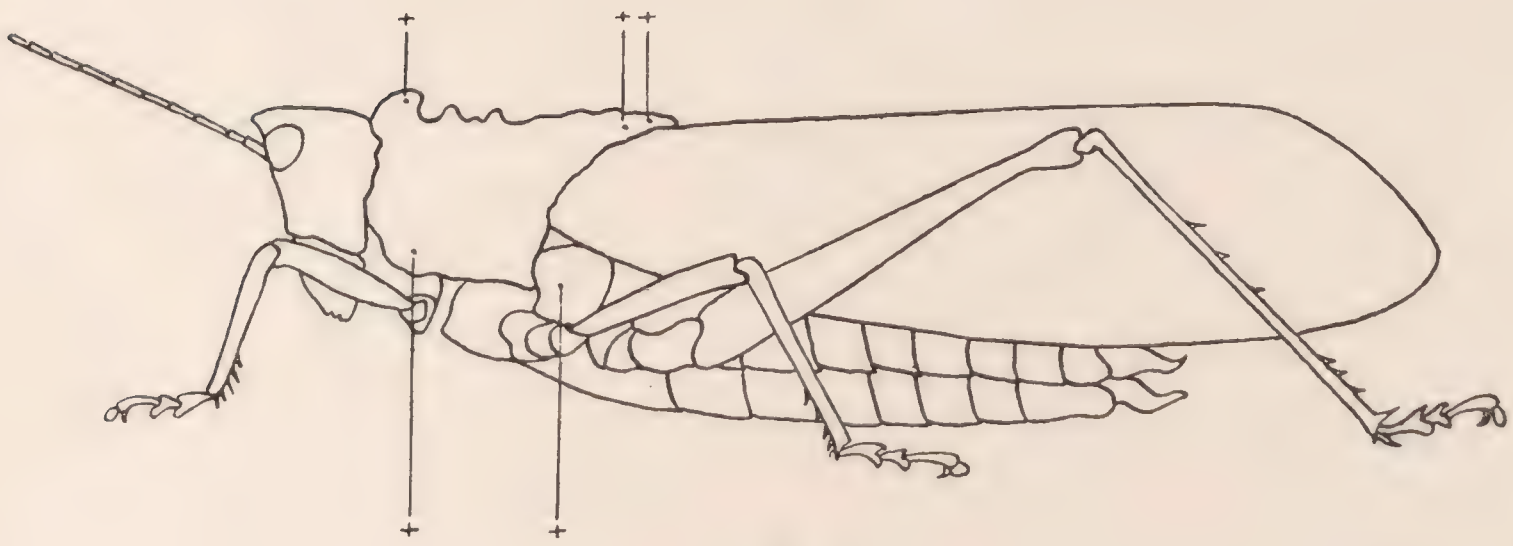

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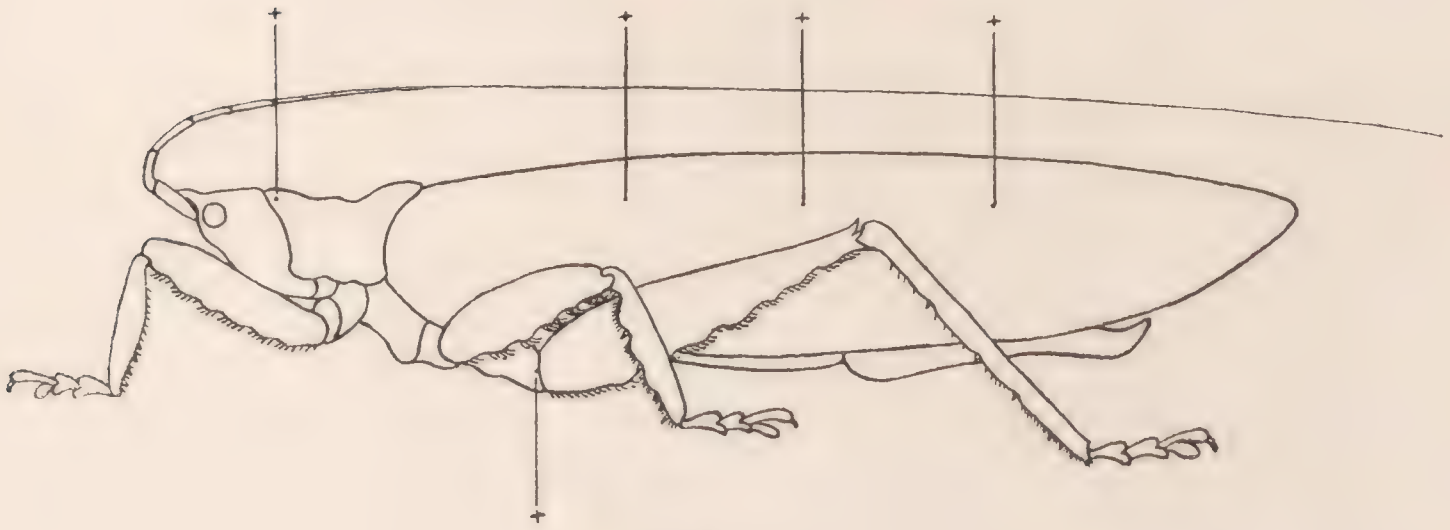

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R. W. G. Hingston, del. *Vaus & Crampton, Ltd.*

THE LIQUID-SQUIRTING HABIT OF ORIENTAL GRASSHOPPERS.

ON THE AFRICAN SPECIES OF THE GENUS *MESOCHORUS*, GRAV. (FAM. ICHNEUMONIDAE)

By D. S. Wilkinson,
(Senior Assistant, Imperial Bureau of Entomology.)

[Read March 2nd, 1927.]

With Seven Text-figures.

Up to now only three species of *Mesochorus* have been described from Africa; and since the British Museum and the Imperial Bureau of Entomology are in possession of considerable material it seems advisable to bring up to date our knowledge of the African species of this genus.

The species already described from this region are *M. melanothorax*, Wilkn., *M. nox*, Morl., and *M. herero*, End.; unfortunately I have not been able to see the type of Morley's species, which is in the South African Museum, Capetown, but through the courtesy of Dr. E. Titschack, of the Zoological Museum, Hamburg, I have been enabled to see Enderlein's type.

Mesochorus, Grav.

Ich. Eur. II, 1829, p. 960.

Key to the African Species.

1. Notauli strong and discally coalescent; areola apically acute . . . . *nox*.
   Notauli obsolete or completely wanting; areola apically not acute . . 2.
2. Transverse carina below toruli straight . . . . . 3.
   Transverse carina below toruli V-shaped in the middle or at least somewhat sinuate . . . . . 5.
3. Costulae evidently longer than extreme width of areola . . . . . *nigellus*.
   Costulae not longer than extreme width of areola, or not evidently so . 4.
4. Greatest width of areola always before middle; 2nd abd. seg. subcoriaceous . . . . . *nigrans*.
   Greatest width of areola generally at middle; 2nd abd. seg. not at all coriaceous but smooth and shining . . . . . *subniger*.
5. Costulae from beyond middle of areola; thorax and propodeon wholly black . . . . . *melanothorax*.
   Costulae from middle or from before middle of areola; thorax and propodeon not wholly black . . . . . 6.
6. Propodeon parti-coloured with light and dark . . . . . 7.
   Propodeon of same colour throughout, or if with two colours then both dark . . . . . 9.
7. Areola and basal areae of propodeon together longer than petiolar area 8.
   Areola and basal areae together shorter than petiolar area . . . *decoratus*.
8. Propodeon with basal area apically subacute, and with greatest width of petiolar area before middle . . . . . *ornatus*.
   Propodeon with basal area apically broad, and with greatest width of petiolar area at middle . . . . . *excultus*.
9. Thorax mainly red-testaceous . . . . . *herero*.
   Thorax mainly black . . . . . *incertus*.

Mesochorus nox, Morl.

Mesochorus nox, Morley. Ann. S. Afr. Mus., xxiii, 1926, p. 480.

"♀. A small and shining black species with luteous markings, and abdominal disc subcircularly pale. Head finely and sparsely punctate, testaceous, with occiput, ocellar region, frons and mandibular apices black; clypeus short, broad, basally not discreted and apically truncate; mandibles stout and apically bidentate, the lower tooth the longer; palpi whitish. Antennae filiform, very slender, nigrescent and longer than body. Thorax with strong and discally coalescent notauli; prothorax entirely flavescent-testaceous; metathorax nitidulous and nearly smooth, with complete areae and lateral pubescence; basal area elongate and entire; areola diamond-shaped, longer than broad, apically acute, emitting strong costulae slightly before its centre; petiolar area discreted, not reaching metathoracic centre and pale testaceous throughout; lateral carinae strong, spiracles circular and not small. Scutellum convex, neither small nor laterally margined, very finely punctate, shining and testaceous with apex mutic, its base and glabrous basal fovea black. Abdomen fusiform with first segment narrowly before the base, second except basally and third except apically, luteous; postpetiole explanate, smooth, longitudinally impressed centrally and as long as the stout and black terebra, or fully a third of the abdominal length. Legs stout and pale testaceous with both extremities of the stramineous-white hind tibiae definitely, their coxae discally in the centre, and femora indefinitely, black; inner hind calcar two-thirds metatarsal length and distinctly longer than the outer. Wings hyaline, somewhat broad; radix whitish, stigma and nervures nigrescent; basal nervure continuous, and the upper curved radial cell broad; areolet large, obliquely quadrate and distinctly sessile, emitting recurrent nervure before its centre; discoidal cell basally subacute; nervellus opposite, straight and not intercepted. Length 3 mm., ♀ only.

M'fongosi in Zululand during May 1917, by W. E. Jones. It is most closely allied to *M. pictilis,* Holmgr., though with the cheeks neither elongate nor striate."

This is the only species of *Mesochorus* recorded from Zululand; it has not been seen by the present writer, but it would appear that it offers numerous characters whereby it may be separated readily from the other African species herein described.

Mesochorus nigellus, sp. n.

Face, cheeks, frons, propleurae, all legs (except about apical $\frac{1}{4}$ of, and touch at base of, hind tibiae, and whole of hind tarsi, which are brownish), tegulae, and extreme apex of 2nd segment, pale testaceous to reddish testaceous; mesopleurae and occiput red; mesonotum black, very slightly tinged with red; propodeon, abdominal tergites except apex of 2nd, and ovipositor sheathes, black; integument, particularly that of the abdominal tergites, polished and shining; antennae dull brown; stigma and wing-veins tinged with light red-brown; ocelli in a dark spot.

♀. *Head* short, broader than thorax; clypeus not differentiated from face; face lightly and somewhat sparsely punctate, with a straight, strong, transverse carina running below, and connecting the apices of, the toruli, face exhibiting also a slightly raised striolate median area which extends from the transverse carina to the base of an elongately pear-shaped depressed area which reaches from middle of frons to apex of clypeus; clypeus virtually impunctate, except for a line of strong punctuations along extreme apex; lower facial orbits striate; cheeks, vertex, and occiput impunctate and smooth; antennae filiform, longer than head, thorax, and abdomen together, rather more than twice as long as abdomen; 1st flagellar joint about equal to the scape in length, and rather shorter than the 2nd and 3rd joints combined; flagellar joints 32; face sparsely, antennae thickly, pubescent. *Thorax:* Mesonotum very lightly and sparsely punctate, almost completely

smooth, with fairly dense white pubescence; mesopleurae with some light punctures, and somewhat pubescent, otherwise smooth; basal depression of scutellum with lateral carinae which continue round the posterior lateral margins of the mesonotum; scutellum longer than broad, smooth and impunctate with, apparently, a minute apical tooth; propodeum (Fig. 1) with at least eleven superior areae: basal area definitely separated from areola; areola at greatest breadth, which is almost exactly at the middle, somewhat broader than base of basal area, about twice as long as broad, with base about $\frac{1}{2}$ of, and with apex about $\frac{1}{3}$ of, extreme width, the apical sides not always straight, but sometimes slightly curved or even angled; petiolar area about as broad as long, with greatest breadth, which is at about middle, broader than apex, which latter is about as broad as length of costulae. *Wings* hyaline, thickly haired; nervulus interstitial or very slightly postfurcal; nervus

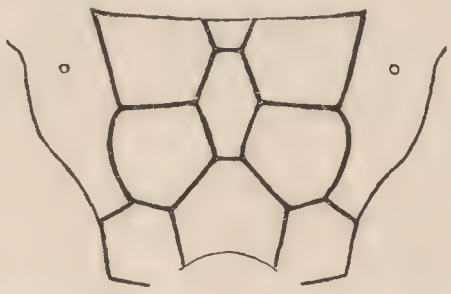

FIG. 1.—*M. nigellus*, sp. n. Areation of propodeon.

parallelus emitted from above middle of brachial cell; areolet sessile, neither true rhombic nor rhomboidal, no side quite equalling another in length, the recurrent nervure before middle; nervus discocubitalis not evenly arched; nervellus straight and unbroken. *Legs* pubescent; hind coxa with its trochanters together somewhat longer than petiole; the longer hind alcar half as long as basal joint of hind tarsus, which latter is as long as the 2nd, 3rd, and 4th joints together. *Abdomen:* Petiole not or hardly arched, with spiracles beyond middle, and with its apex about twice as broad as base, the apex being rather less than $\frac{1}{4}$ total length of petiole; petiole more or less smooth, postpetiole aciculate except at extreme apex; 2nd segment longer than broad; 3rd segment if anything shorter than 2nd; 2nd and succeeding tergites smooth, polished, and shining; ovipositor sheathes shorter than middle femora, longer than 2nd segment, about equal to basal joint of hind tarsus.

Length 3 mm.
Uganda, Jinja, 6.vi.1916 (*C. C. Gowdey*).
6 ♀♀. Type in British Museum.
Recorded as parasitic on an unidentified species of Braconid.

Mesochorus nigrans, sp. n.

Agrees with *M. nigellus*, m., in colour except for the following: Mesopleurae blackish-red to dark brownish-red, especially in the males, where the upper half is almost completely black; mesonotum black with two converging streaks of red along the line of the more or

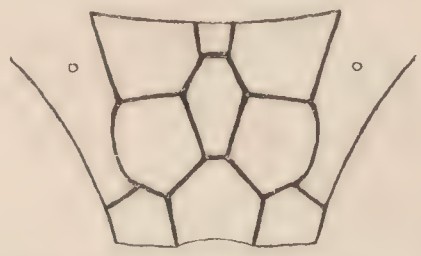

FIG. 2.—*M. nigrans*, sp. n. Areation of propodeon.

less completely obsolete notauli; scutellum mostly red; hind coxae of males brownish-red; integument of the abdominal tergites subcoriaceous.

♂♀. Agree with *M. nigellus*, m., in sculpture except for the following. *Head:* Pear-

shaped area on face not so well marked, and not or hardly depressed; cheeks of female more or less impunctate, of the male, punctate; lower facial orbits of male smooth; flagellar joints 36. *Thorax* with mesonotum closely and regularly but somewhat lightly punctate; mesopleurae with not so close but with very definitely more pronounced punctuations than the mesonotum, and with considerably more pronounced punctuations than in *M. nigellus*; scutellum lightly and sparsely punctate; propodeum (Fig. 2) with lateral sides of basal area more or less parallel; areola not twice as long as greatest breadth, the apical sides apparently always straight; the greatest breadth of the areola, which is before middle, and which is not so broad as apex of petiolar area, as great or greater than length of costulae; petiolar area as broad as long. *Wings* with the nervulus postfurcal, and the nervus discocubitalis evenly arched. *Legs* with the basal joint of the hind tarsus longer than the 2nd, 3rd, and 4th joints together. *Abdomen :* 2nd segment transverse or at the most as long as apical width; 2nd and 3rd segments in their basal halves with some weak punctuation-like impressions; ovipositor sheathes about equal in length to 2nd segment.

Length 4 mm.
South Africa, Mossel Bay, Cape Province (*R. E. Turner*).
1 ♀ (type) and 2 ♂♂, 18–30.xi.1921; 2 ♂♂, 1–14.xi.1921; 1 ♂, Aug. 1921; and 1 ♀, Dec. 1921.
Type in British Museum.
Of the above characters by far the most important is the subcoriaceous condition of the abdominal tergites.

Mesochorus subniger, sp. n.

Agrees with *M. nigellus*, m., in colour except for the following: Whole of basal half of 3rd abdominal segment and apical half of 2nd, with in addition the basal median portion of 2nd, red-testaceous—this testaceous marking of the abdominal tergites is, however, very variable in extent; mesopleurae and occiput red-testaceous; mesonotum black, with streaks of the same red-testaceous colour along the line of the obsolete notauli, with the area between these streaks varying from wholly red-testaceous to basal half red-testaceous with apical half black; scutellum mostly red-testaceous; of the propodeum, the basal, petiolar, external, and dentiparal areae and the areola are black, the remainder red-testaceous.

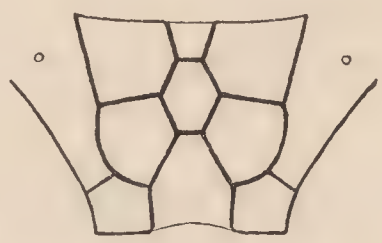

Fig. 3.—*M. subniger* and *M. excultus*, spp. n. Areation of propodeon.

♂♀. Agree with *M. nigellus* in sculpture except for the following. *Head :* Pear-shaped area on face well marked but not depressed; face strongly, cheeks somewhat, punctate; lower facial orbits of male only somewhat striate; flagellar joints generally 36. *Thorax :* Mesonotum closely and regularly but somewhat lightly punctate; mesopleurae with not so close but with very definitely more pronounced punctuations than mesonotum, and with considerably more pronounced punctuations than in *M. nigellus ;* scutellum with some punctuations; propodeum (Fig. 3) with lateral sides of basal area not parallel; areola not twice as long as greatest breadth, the apical sides straight; greatest breadth of areola, which is at middle, and which is not as broad as apex of petiolar area, as great as the length of the costulae; apex and base of areola of about equal length, and rather less than half its extreme width; petiolar area longer than broad with greatest breadth at about middle. *Wings* with nervulus postfurcal and nervus discocubitalis evenly arched. *Legs :* Hind

coxa with its trochanters about equal in length to petiole; basal joint of hind tarsus longer than 2nd, 3rd, and 4th joints together. *Abdomen* with its 2nd segment in the female strongly transverse, in the male mostly as long as apically broad.

Length 3·5–4·0 mm.

South Africa, Mossel Bay, Cape Province (*R. E. Turner*).

3 ♀♀ (one of which is the type), and 5 ♂♂, 5–31.vii.1921; 3 ♀♀, 18–30.xi.1921; 3 ♀♀ and 4 ♂♂, August, 1921; 1 ♀, October, 1921; 2 ♂♂, December, 1921; 1 ♂, June, 1921; and South Africa, Umbilo, Durban, Natal (*A. L. Bevis*), 1 ♀, December, 1916.

Type in British Museum.

Although the areation of the propodeon and the colour markings generally are subject to variation in all the species herein brought forward as new, it seems that *M. subniger* is particularly liable to such variation. The areola of this species occasionally becomes elongated apically, in which condition the costulae are before middle, as in *M. nigrans*.

Mesochorus melanothorax, Wilkn.

Mesochorus melanothorax, Wilkinson. Bull. Ent. Res., xvii, Part 3, 1927, p. 310.

This recently described species was bred by Mr. G. S. Cotterell in Asamankese, Gold Coast, from *Sahlbergella singularis,* Hagl., at the same time as *Euphorus sahlbergellae,* Wilkn., and it is therefore doubtless parasitic on this latter species.

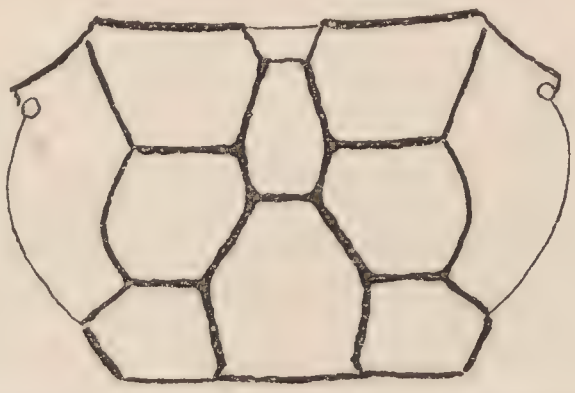

Fig. 4.—*M. melanothorax,* Wilkn. Areation of propodeon.

M. melanothorax is easily separable from all the other species herein dealt with by the shape of the transverse carina below the toruli, by the point of emission from the areola of the costulae (Fig. 4), and by the coloration of the thorax and propodeon.

Mesochorus ornatus, sp. n.

Head, scape, prothorax, mesopleurae, a large median portion of mesonotum, scutellum, propodeon mostly, the four anterior legs, 2nd abdominal segment mostly, basal half of the 3rd segment, and the male processes whitish-testaceous to reddish-testaceous; ocelli in a dark spot; mesonotum with each lateral $\frac{1}{4}$ black, and anteriorly with two brownish streaks on the median testaceous area; the basal, external, and dentiparal areae of the propodeon black; hind coxae testaceous with a brownish touch on upper apex; hind trochanters testaceous; hind femora testaceous with a brown streak on each inner and outer side; basal $\frac{1}{6}$ and apical $\frac{1}{4}$ of hind tibiae brown, remainder testaceous; hind tarsi brown; petiole black, except at apex in middle which is testaceous; 2nd segment with a triangle of black on each basal angle, the black not meeting across the base of the segment, but extending $\frac{2}{3}$ distance along lateral margin; lateral margins at base of, and whole of apical half of, 3rd segment reddish-black; all succeeding tergites black on top, dark reddish on sides;

antennae dull brown; stigma and wing veins very faintly tinged with brown; integument, particularly of the abdomen, polished and shining.

♂. Head short, broader than thorax; clypeus not differentiated from face; face evenly punctate; clypeus virtually impunctate, except for a line of strong punctuations along extreme apex; face with a strong transverse carina, which is V-shaped in the middle, running below, and connecting the apices of, the toruli, and with a slightly raised median striolate area running from this transverse carina to base of clypeus; clypeus without an elongated pear-shaped depression; cheeks and outer orbits punctate; lower facial orbits striate; antennae filiform, somewhat longer than head, thorax, and abdomen together, nearly three times as long as abdomen; 1st flagellar joint somewhat longer than scape, but shorter than 2nd and 3rd joints combined; flagellar joints 32; face, cheeks, and occiput below pubescent; antennae not very noticeably strongly pubescent. *Thorax* as a whole fairly evenly and lightly punctate and clothed with whitish pubescence, except only possibly scutellum and propodeon which are more sparsely punctate and pubescent; basal depression of scutellum with lateral carinae which continue round the posterior lateral margins of the mesonotum; scutellum longer than broad, with a few very weak punctures, and apparently with minute apical tooth; propodeon (Fig. 5) with at least eleven superior areae: basal area triangular; areola at greatest breadth, which is almost exactly at middle, about equal

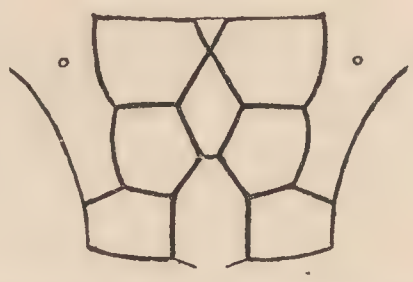

Fig. 5.—*M. ornatus*, sp. n. Areation of propodeon.

to costulae, not twice as long as broad, with apex if anything somewhat less than $\frac{1}{4}$ of greatest breadth; petiolar area definitely longer than broad, as broad at apex as greatest breadth, which is before middle; external areae broader at base than apex, basally broader than petiolar area. *Wings* hyaline, evenly but not very thickly haired; nervulus interstitial; nervus parallelus emitted from above middle of brachial cell; areolet sessile, neither true rhombic nor rhomboidal as the recurrent is somewhat before middle and no side quite equals another in length; nervus discocubitalis evenly arched; nervellus straight and unbroken. *Legs* pubescent; hind coxa with its trochanters together somewhat longer than periole; the longer hind calcaria longer than half basal joint of hind tarsus, which latter is as long as the 2nd, 3rd, and 4th joints together. *Abdomen* smooth and unsculptured; petiole not or hardly arched, with its spiracles beyond middle, and with its apex about one and a half times as broad as base, and rather smaller than $\frac{1}{3}$ total length of petiole; towards base the petiole narrows to rather more than half basal width; the sides of the postpetiole almost parallel; petiole and postpetiole entirely smooth, shining and unsculptured, except for a small, somewhat deeply impressed, elongate area lying between the spiracles and the apex of the petiole, on each side; 2nd segment longer than broad, definitely longer than 3rd, which is transverse; male processes in length shorter than 3rd segment.

Length 3·75 mm.
Uganda, Kampala, 1.viii.1917 (*C. C. Gowdey*).
2 ♂♂. Type in British Museum.

Mesochorus decoratus, sp. n.

Head except ocelli which are in a dark spot, prothorax, mesonotum at base in the middle and two lines running in much the direction of the more or less completely obsolete notauli,

the tegulae, mesosternum, small area high up on mesopleurae, scutellum, areola, petiolar, and postero-intermedial and postero-external areae of propodeon, the four anterior legs, hind trochanters and trochanterines, median portion of hind tibiae, a more or less circular median area on apical half of 2nd and basal half of 3rd segment, and the 3rd and 4th segments at the sides, pale testaceous; hind tarsi and male processes reddish; hind femora and inner sides of hind coxae dark reddish; basal $\frac{1}{6}$ and apical $\frac{1}{4}$ of hind tibiae, and all remainder of integument black; mandibular teeth black; stigma and wing veins dark brown; integument of 3rd and succeeding abdominal segments faintly subcoriaceous and shining.

♂. *Head* short, broader than thorax; clypeus not differentiated from face, the latter evenly and strongly punctate, the former virtually impunctate except for a few very strong punctures at extreme apex; face with a strong, slightly sinuate, transverse carina running below, and connecting the apices of, the toruli, with a strong, double-edged keel running from middle of the transverse carina a little way down the face; lower facial orbits somewhat striate; mandibular teeth equal; antennae with 1st flagellar joint as long or longer than 2nd and 3rd joints together. *Thorax* as a whole including the propodeon, and the hind coxae, very strongly punctate and lightly covered with reddish pubescence; basal depression

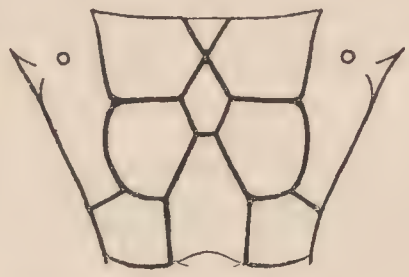

FIG. 6.—*M. decoratus*, sp. n. Areation of propodeon.

of scutellum with lateral carinae; scutellum with strong apical tooth; propodeon (Fig. 6) with at least eleven superior areae: basal area apically narrower, nearly triangular, virtually as long as half length of areola, as broad at base as greatest breadth of areola; areola broader at apex than base, with greatest breadth shorter than length of costulae and about twice apical breadth, not twice as long as broad; petiolar area elongate, longer than basal area and areola combined, nearly as broad at apex as at greatest breadth, which is at middle, the greatest breadth being about equal to costulae; external area nearly if not quite as broad at apex as base. *Wings* not very thickly haired; nervulus interstitial; areolet sessile, almost true rhombic. *Legs* with the hind coxa and its trochanters somewhat shorter than petiole; the longer hind calcaria longer than half basal joint of hind tarsus, which latter is as long as the four apical joints. *Abdomen* smooth and unsculptured, except for a few isolated and scattered punctures particularly on postpetiole; petiole not or hardly arched; postpetiole with its sides parallel; 2nd segment longer than broad, and longer than 3rd segment; male processes longer than 2nd segment but not as long as petiole.

Length 6 mm.
South Africa, Pondoland, Port St. John, 10–31.vii.1923 (*R. E. Turner*).
1 ♂. Type in British Museum.

Mesochorus excultus, sp. n.

Agrees with *M. decoratus* in colour with the following exceptions: Occiput blackish, and antennae dull brown; mesonotum and mesopleurae darkish red with some black markings; spiracular areae pale testaceous, as are also the hind coxae except for a dark apical spot; the sides of the 4th and succeeding abdominal segments pale.

♀. Agrees with *M. decoratus* in sculpture except for the following: *Head* with facial orbits below, and cheeks, strongly striate; the lower tooth of the mandibles decidedly the

longer. *Thorax* including propodeon, and hind coxae, with punctuations not quite so strong as in *M. decoratus*; apical tooth of scutellum not apparent; areation of propodeon (Fig. 3) as for *M. subniger*, m.; pubescence whitish. *Wings* with the recurrent somewhat before middle of areolet. *Abdomen* with 2nd segment hardly longer than broad, and ovipositor sheathes longer than 2nd segment but not as long as petiole.

Length 4·5 mm.
South Africa, Natal, Kloof, 1,500 feet, August, 1926 (*R. E. Turner*).
1 ♀. Type in British Museum.
Superficially very like *M. decoratus*, m., but differing markedly from that species in the areation of the propodeon.

Mesochorus herero, End.

Mesochorus herero, Enderlein. Michaelsen, Beitr. Kenn. Land- u. Susswass. fauna D.S.W. Afrikas, Enderlein, 1914, p. 216.

Head, except for facial orbits and base of mandibles, which are pale, and for dark spot round ocelli, thorax, all legs, propodeon, and male processes, red-testaceous; antennae brown; apex of mandibles, abdominal tergites except apex of 2nd, and most of 3rd which are reddish, black; stigma and wing-veins light brown-red; integument of abdomen smooth and polished.

♂. *Head* short, broader than thorax; clypeus not differentiated from face, both clypeus, face, and facial orbits evenly and strongly punctate, more or less throughout; lower facial orbits not striate; face with the sinuate transverse carina as previously described; mandibular teeth equal; 1st flagellar joint not so long as 2nd and 3rd together; flagellar joints 34. *Thorax :* Mesonotum towards base in middle punctate, otherwise more or less impunctate;

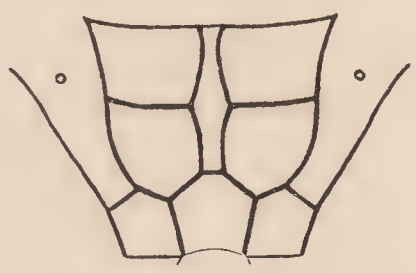

Fig. 7.—*M. herero*, End., and *M. incertus*, sp. n. Areation of propodeon.

mesopleurae with light punctures; basal depression of scutellum with lateral carinae which continue round the posterior lateral margins of the mesonotum; scutellum with some punctures; propodeon (Fig. 7) with at least eleven superior areae: areola elongate and attenuated and not separated from basal area, broader apically than basally, with the costulae more than twice as broad as extreme width; petiolar area with extreme width, which is before middle, about equal to or somewhat less than length of costulae, and with apex somewhat narrower. *Wings* hyaline; nervulus interstitial; nervus parallelus from above middle of brachial cell; areolet more petiolate than sessile, almost true rhombic; nervus discocubitalis evenly arched; nervellus straight and unbroken. *Legs* pubescent; hind coxa with its trochanters about equal to petiole in length; the longer hind calcar half as long as basal joint of hind tarsus, which latter is as long as the 2nd, 3rd, and 4th joints together. *Abdomen :* Petiole not or hardly arched, with spiracles just beyond middle, and with its apex about $\frac{1}{4}$ its total length; postpetiole of two specimens in the British Museum elongately excavated except at immediate apex, postpetiole of type more or less smooth and not so excavated; 2nd segment longer than broad; 3rd segment shorter than 2nd and transverse; all tergites pubescent and shining; male processes in length equal to 3rd segment.

Length 5 mm.
Type locality : German South-west Africa, Okahandja. The British Museum

possesses two specimens labelled as follows: South Africa, Natal, Kloof, Durban, 7.xi.1926 (*A. L. Bevis*), and South Africa, Transkei, Umtata, 18,ii–18.iii.1923 (*R. E. Turner*).

Mesochorus incertus, sp. n.

Facial orbits, clypeus, mandibles except teeth which are black, cheeks below, and tegulae, pale yellow; remainder of head capsule, median portion at base of mesonotum with two lines running much along the line of the notauli were the latter present, scutellum, propodeon somewhat apically, all legs except apex of hind coxae which are black and except hind tarsi which are brownish, extreme apex of 2nd abdominal tergite, male processes, reddish-testaceous; ocellar region, remainder of thorax and abdominal tergites, black, except for some light markings on the apical tergites; antennae dark brown; stigma and wing veins light reddish-brown.

♂. Agrees with *M. herero* in sculpture except for the following: Clypeus particularly and facial orbits not so punctate as in *M. herero,* the median apical half of clypeus being entirely impunctate except for five large punctuations; flagellar joints 31; spiracles of petiole more or less exactly at middle; petiole and postpetiole with only a slight longitudinal impression.

Length 4·5 mm.

South Africa, Cape Province, Mossel Bay, 1–3.vii.1921 (Type), and 5–31.vii.1921 (*R. E. Turner*).

2 ♂♂. Type in British Museum.

ON THE SOUTH AFRICAN SPECIES OF *NANOPHYES* (COL. CURCULIONIDAE) AND SOME ALLIED GENERA

By Guy A. K. Marshall, C.M.G., D.Sc., F.R.S.

[Read March 2nd, 1927.]

Plate X and Three Text-figures.

Up to the present time only four species of *Nanophyes*, Schh. 1838, have been recorded from South Africa; but this is doubtless due to the fact that these small weevils were almost entirely neglected by the earlier collectors, for it seems probable that this genus is really quite as well represented in Africa as it is in Europe.

It was long ago pointed out by Faust (*Stett. ent. Zeit.*, 1888, p. 298, footnote) that Lacordaire had quite misapprehended the relationships of *Nanophyes* and *Ctenomerus*, Schh. 1843, in spite of their obviously close affinity. While agreeing, further, with Faust that the presence of elongate trochanters in these two genera indicates that they should be placed in close proximity to the Apioninae, his statement that they should be included in that subfamily seems to be unsatisfactory, because there are so many important characters in which the two groups differ. For example, the Apioninae have the antennae non-geniculate and inserted on the lower surface of the rostrum, the funicle being 7-jointed; the tarsal structure is constantly different and the claws are appendiculate or bifid; the scutellum is visible; and the base of the elytra never exhibits the granular carinate margin which is so characteristic of all the genera allied to *Nanophyes*. On this account I prefer to follow Bovie (*Gen. Insect.*, Nanophyinae) in treating the group as a distinct subfamily.

The following is a key to the genera known to me, those not occurring in South Africa being printed in brackets.

Key to Genera of Nanophyinae.

1. (4) Tarsal claws free; the club of the antennae compact; the funicle with four or five joints.
2. (3) Femora dentate . . . . . *Corimalia*, Gozis.
3. (2) Femora not dentate . . . . . (*Nanomicrophyes*, Pic.).
4. (1) Tarsal claws connate or fused into one.
5. (12) Funicle of antennae five-jointed.
6. (11) Tibiae with the upper angle of the corbel not produced into a tooth; head oval or pear-shaped, the outline of the forehead continuous with that of the rostrum or rising from it at a low angle; rostrum gently curved, mandibles without a lateral tubercle.
7. (10) Front coxae touching anterior margin of prosternum; forehead simple; body diamond-shaped or boat-shaped, the dorsal outline strongly convex; the external basal angle of the elytra slightly produced downwards.
8. (9) Antennal club with the two basal joints not or very slightly shorter than the rest; the posterior pairs of tibiae slender and not denticulate; elytra with the intervals all of equal height and never nodulose, the humeral calli not very prominent and never carinate, the greatest projection being on interval 7 . . . . . *Nanophyes*, Schh.

9. (8) Antennal club with the two basal joints much shorter than the rest; the posterior pairs of tibiae much thickened in the apical two-thirds and denticulate on the lower side; elytra with the alternate intervals more raised and more or less nodulose, the humeral calli very prominent and carinate, the greatest projection being on interval 8 (*Diacritus*, Pasc.).
10. (7) Front coxae almost as far from the anterior as from the posterior margin of the prosternum; forehead with a small elevation on the basal half; body oblong-ovate, the dorsal outline flattened from the middle of the pronotum to the middle of the elytra; the external basal angle of the elytra not produced *Amphibolocorynus*, Schh.
11. (6) Tibiae with the upper angle of the corbel produced into a stout tooth; head globular, the outline rising abruptly from that of the rostrum; rostrum strongly curved, mandibles with a minute, outwardly projecting tubercle on the lower lateral margin towards the base; the external basal angle of the elytra not produced *Phoroctenus*, gen. n.
12. (5) Funicle of antennae six-jointed.
13. (14) Elytra with distinct humeral calli and with the external basal angle produced downwards, interval 8 granulate or carinate in the basal half; the space between the median coxae as broad as or broader than that between the hind coxae . . . . . *Ctenomerus*, Schh.
14. (13) Elytra with the humeral calli very feeble or absent, and the external basal angle not produced, interval 8 never granulate or carinate; the space between the median coxae much narrower than that between the hind coxae . . . . . *Hexatmetus*, gen. n.

It is proposed to deal here fully with only those genera that have four or five joints in the funicle, leaving *Ctenomerus* and its allies for a later paper.

Genus **CORIMALIA,** Gozis.

This genus has not previously been recorded from South Africa, and I have seen only the following new species.

Corimalia damarensis, sp. n.

♂. Integument very pale yellow, rather thinly clothed above with white hair-like scales, which are much broader and denser on the forehead and below the eyes, at the sides and base of the pronotum, and at the base of interval 2 on the elytra; the mouth-parts and the vertex of the head testaceous brown; the metasternum, the crenulated basal margin of the elytra, the apical half of the claws, and the tips of the femoral teeth blackish; the elytra with an elongate orange-brown spot at about the middle of interval 5 and a similar shorter one on interval 3.

Head with the eyes slightly raised above the general outline of the vertex, the forehead about as wide as the apex of the first joint of the funicle and without any fovea; the vertex with very sparse scale-hairs. *Rostrum* as long as the pronotum, straight, very slightly widening from base to apex, devoid of scaling except at the extreme base, very finely and sparsely punctate, and with four rows of coarser subconfluent punctures from the base to the insertion of the antennae, which is at the middle. *Antennae* with the funicle 5-jointed. *Prothorax* transverse (3 : 2), conical, with the sides quite straight, the apex being a little more than half the width of the base; the dorsal outline gently curved and sloping rather steeply forwards; the clothing sparse and hair-like on the disk, turning into denser elongate white scales at the sides and base. *Elytra* ovate, longer than broad (9·5 : 8), widest somewhat in front of the middle, the shoulders not prominent, the

basal margin shallowly sinuate; the striae rather shallow and containing somewhat indistinct punctures, the intervals gently convex and impunctate; evenly and thinly clothed with white setiform scales, those at the base of interval 2 being much broader and like the ones at the sides of the prothorax. *Legs* sparsely clothed with white setae; the femora stout, with one long and one short tooth; the front tibiae rather longer than the others, and thinner and more curved at the base; the tarsi distinctly shorter than the tibiae, joint 3 a little shorter and broader than 2. *Sternum* with dense white scales on the meso- and metasternum like those on the sides of the prothorax. *Venter* with sparse narrow scales.

Length, 1·8 mm.; breadth, 1 mm.

South West Africa: 2 ♂♂, Svakop R. (*J. Wahlberg*).

Type in the Stockholm Museum; cotype in the British Museum.

In facies, sculpture and colouring this species very closely resembles *C. centromaculata*, Costa, from North Africa.

Genus **NANOPHYES**, Schh. 1838.

Of the four previously known South African species I have been able, through the kindness of my friend Prof. Dr. Y. Sjöstedt, to examine typical specimens of the three described by Boheman. Two of these, *N. armatus* and *N. wahlbergi*, belong to the present genus, but the third, *N. pusio*, has six joints in the funicle, besides differing in other characters, so that a new genus is proposed for it below. The fourth species, *N. achillei*, Pic, I have not seen, and it is possible that it may not belong to the genus *Nanophyes* as here defined.

This genus is much more strongly represented on the eastern than on the western side of the sub-continent, and most of the species appear to be somewhat narrowly localised in their distribution; but two species, *N. armatus*, Boh., and *N. errans*, sp. n., extend from Cape Province up to Southern Rhodesia, an unusual range among the Curculionidae.

Key to the Species of *Nanophyes*.

1. (34) Elytra without a row of granules or a fine granulate carina on the basal third of interval 8.
2. (17) Prothorax and elytra entirely black.
3. (8) Front femora with one large and two small teeth; length (without rostrum) 2·0–2·5 mm.
4. (5) Trochanters and antennal scape testaceous; joint 4 of funicle as long as broad . . . . . *trochanteratus*, sp. n.
5. (4) Trochanters black, scape black or piceous; joint 4 of funicle strongly transverse.
6. (7) Carinae on rostrum ceasing at the antennae; pronotum with the longitudinal outline almost flat, clothed with long fine dark grey hairs and a median stripe of white hairs; elytra with fine brown hairs (at least four abreast on an interval) and a quadrate pale scutellar patch, the hairs at the base of intervals 1 and 2 being white *palustris*, sp. n.
7. (6) Carinae on rostrum continued well beyond the antennae; pronotum with the longitudinal outline distinctly convex, clothed with sparser shorter broader greyish white hairs throughout; elytra with hairs like those on the pronotum (three rows to an interval in front and two behind), but those at the base of intervals 3–5, on the basal half of interval 2 and throughout interval 1, brownish . *planifrons*, sp. n.

8. (3) Front femora with only one or two teeth.
9. (14) Front femora with two teeth; length (without rostrum) 1·5–1·8 mm.
10. (11) Femora with two minute teeth of almost equal size; trochanters black or blackish; prothorax half as long as its basal width; elytra with the hairs white, except on a large indistinct triangular basal patch and along interval 1, where they are brown . . *probus*, sp. n.
11. (10) Femora with one tooth much larger than the other; trochanters red-brown or yellow; prothorax longer than half the basal width.
12. (13) Hairs on elytra whitish, but mingled with brown ones on the disk towards the base, and those on interval 1 entirely brown; trochanters red-brown, base of femora black . . . . *deceptor*, sp. n.
13. (12) Hairs on elytra white at the sides and brown on the disk, except for a few white ones at the base of interval 2 and a transverse common patch of white hairs about the middle extending on each elytron to interval 3; trochanters and base of femora flavous *importunus*, sp. n.
14. (9) Front femora with only a single minute tooth; length 1·2–1·4 mm.
15. (16) Form more narrowly elliptical, length of elytra to breadth as 4·5 : 3; rostrum regularly curved; head as seen from above (with rostrum extended) almost semicircular, with the eyes very close to front margin of pronotum; front tibiae parallel-sided in the apical half . . . . . *ellipticus*, sp. n.
16. (15) Form normal, diamond-shaped, length of elytra to breadth as 3·7 : 3; rostrum straight in the basal half and almost porrect; head as seen from above markedly conical, the eyes distant from the pronotum; front tibiae slightly narrowing from middle to apex . . . *pumilus*, sp. n.
17. (2) Elytra mainly or partly flavous or testaceous.
18. (29) Elytra widest at the shoulders; body with some blackish colouring above or below; femora with not more than two teeth.
19. (28) Femora with two small black teeth; prothorax and elytra with black markings on the integument.
20. (21) Pronotum black, with a yellow median stripe; elytra black, with a common broad angulated band about the middle and a small yellow dot at the base of interval 2 . . . . . *balteatus*, sp. n.
21. (20) Prothorax and elytra predominatingly testaceous yellow or light brown.
22. (25) Elytra with transverse rows of dark spots (occurring only on intervals 1, 3, 5, 7) behind the darker basal triangle; front femora with a distinct dark brown ring towards the apex; pronotum with a median stripe of dense pure white hairs.
23. (24) Only the front femora with a dark ring; elytra with the following black markings (due to darkening of the derm and not merely to black hairs): a transverse angulated basal row of spots, an apical stripe on interval 1, and two apical spots on interval 3 . *eximius*, sp. n.
24. (23) All the femora with a dark ring; elytra with four transverse rows of similar dark spots, the hind row very irregular . . . *pardus*, sp. n.
25. (22) Elytra with at most a spot behind middle on interval 3 (apart from the basal band) and a dark stripe on interval 1; femora without a brown ring; prothorax without a median white stripe.
26. (27) Two basal joints of club transverse; scape nearly one-third longer than club, which is only one-half longer than funicle; ante-antennal part of rostrum of ♂ two-thirds the length of scape; hind tibiae with only a rudimentary mucro . . . . . *errans*, sp. n.
27. (26) Two basal joints of club much longer than broad; scape only one-eighth longer than club, which is a little more than twice as long as funicle; ante-antennal part of rostrum of ♂ slightly less than half the length of scape; hind tibiae with a distinct mucro . *turneri*, sp. n.

28. (19) Femora with only one minute black tooth; prothorax and elytra without any black markings, the metasternum black . . *bevinsi*, sp. n.
29. (18) Elytra widest near the middle; body entirely testaceous, except the eyes and basal margin of the elytra, which are black or blackish.
30. (31) Rostrum with its dorsal surface evenly continuous with that of the forehead; white hairs on elytra broken up into bands and patches beneath which the derm is paler; front femora with three teeth *wahlbergi*, Boh.
31. (30) Rostrum forming more or less of an angle with the forehead; white hairs on elytra rather sparse and evenly distributed; derm unicolorous brown; front femora with only one or two teeth.
32. (33) Eyes more convex behind than the posterior part of the head; antennae with the funicle as long as the scape and longer than the club; femora with two teeth . . . . . *concolor*, sp. n.
33. (32) Eyes quite flat and on a level with the posterior part of the head; antennae with the funicle much shorter than the scape and somewhat shorter than the club; femora with only one tooth. *pulicoides*, sp. n.
34. (1) Elytra with a row of small granules (usually coalescing into a fine granulate carina) on the basal third of interval 8.
35. (40) Femora with three teeth; tibiae without any dark ring; rostrum not differing greatly in length in the two sexes, that of ♀ not or but little longer than the head and pronotum.
36. (39) Forehead linear, much narrower than the club of the scape; pronotum and elytra without black markings.
37. (38) Antennal club concolorous with the rest of the antenna, joint 1 much narrower than 2; apical portion of rostrum in ♀ shorter than the scape (4 : 5); metasternum testaceous brown . . . *blandus*, sp. n.
38. (37) Antennal club darker than the rest of the antenna, joint 1 as broad as 2; apical portion of rostrum of ♀ as long as the scape; metasternum blackish . . . . . *indignus*, sp. n.
39. (36) Forehead as broad as or broader than the club of the scape; pronotum and elytra with black markings . . . . . *armatus*, Boh.
40. (35) Femora with four teeth; tibiae with a dark ring on the basal half; rostrum of ♀ half as long again as the head and pronotum, much longer than that of ♂ . . . . . *nasalis*, sp. n.

Note.—It has not been possible to include in this key *N. achillei*, Pic 1913, because many of the more important structural characters are not given in the description.

Nanophyes trochanteratus, sp. n. (Text-fig. 1.)

♂ ♀. Integument black, with sparse whitish hairs; the elytra with brown hairs on intervals 1 and 2 from the base to the middle of the declivity and also at the base of intervals 3 and 4; on the lower surface the ♂ is clothed with yellowish hair-scales, which are densest on the head just behind the eyes, on the front coxae and on the middle of the mesosternum, these being represented in the ♀ by less dense and finer white hairs.

Rostrum gently curved, nearly as long as (♂) or a little longer than (♀) the head and pronotum; the antennae inserted beyond the middle in both sexes, the apical portion of the rostrum of the ♀ being nearly as long as the scape, and of the ♂ half as long; the dorsum narrowly tricarinate to the antennae, the carinae smooth; the interspaces finely striolate, each bearing a conspicuous row of dense recumbent hairs in the ♂ and sparse minute inconspicuous hairs in the ♀; the apical area with rather large shallow punctures in the ♀, but

scarcely punctate in the ♂, being clothed with hairs. *Antennae*: length of scape 0·60, funicle 0·30, club 0·36 mm.; joint 4 of the funicle quadrate, not broader than 5. *Prothorax* rather shiny, with comparatively stout separated white hairs arising from very shallow transverse lunate impressions, the hairs much shorter and more closely set along the basal margin. *Elytra* with the shoulders much reduced; the striae narrow, containing shallow spaced punctures, the intervals flat and quite smooth; the hairs com-

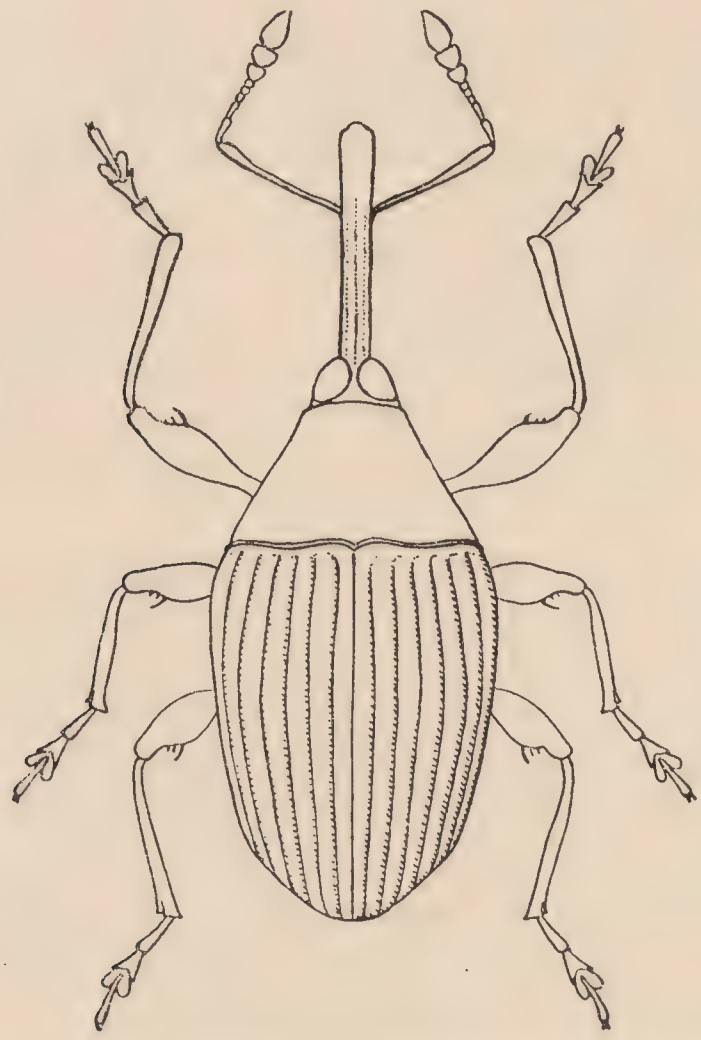

Fig. 1.—*Nanophyes trochanteratus*, sp. n.

paratively stout and not more than three abreast on an interval. *Legs* thinly clothed with white hairs; the femora with one long and two short teeth; the tibiae slender, narrowed but scarcely sinuate internally at the base, the anterior pairs shallowly sinuate in the apical half on the posterior face.

Length, 2·1–2·4 mm.; breadth, 1–1·2 mm.

Natal: Malvern, vi.–x. 1897 (*G.A.K.M.*—type); Durban, 1902 (*F. Muir*).

Described from fifteen specimens.

Nanophyes palustris, sp. n. (Text-fig. 2.)

♂ ♀. Integument dull black, the antennal scape piceous with the apex paler; the pronotum with dark grey hairs and a median stripe of white ones; the elytra with brown hairs and a square common basal patch of white ones extending only to interval 2 on each elytron.

Rostrum almost straight, about as long as the head and pronotum in both sexes and the position of the antennae almost the same, the apical portion in both sexes being much shorter than the scape; the dorsal outline lower than that of the forehead; the dorsum narrowly tricarinate, the carinae ceasing at a little distance before reaching the antennae; the lateral furrow above the false scrobe continued almost to the apex in the ♂, but appearing in the ♀ beyond the antennae only as a line of punctures; the apical area very smooth and with fine sparse punctures in the ♀, more coarsely punctate in the ♂. *Antennae*: length of scape 0·54, funicle 0·30, club 0·45 mm.; joint 4 of the funicle transverse, asym-

metrical, broader than the joints on each side of it. *Prothorax* as in *N. trochanteratus*, sp. n., but a little longer in proportion to its basal width (5 : 8), and the hairs finer and longer and appearing more numerous. *Elytra* with the shoulders prominent; the striae deep and containing shallow spaced punctures, the intervals slightly convex and finely

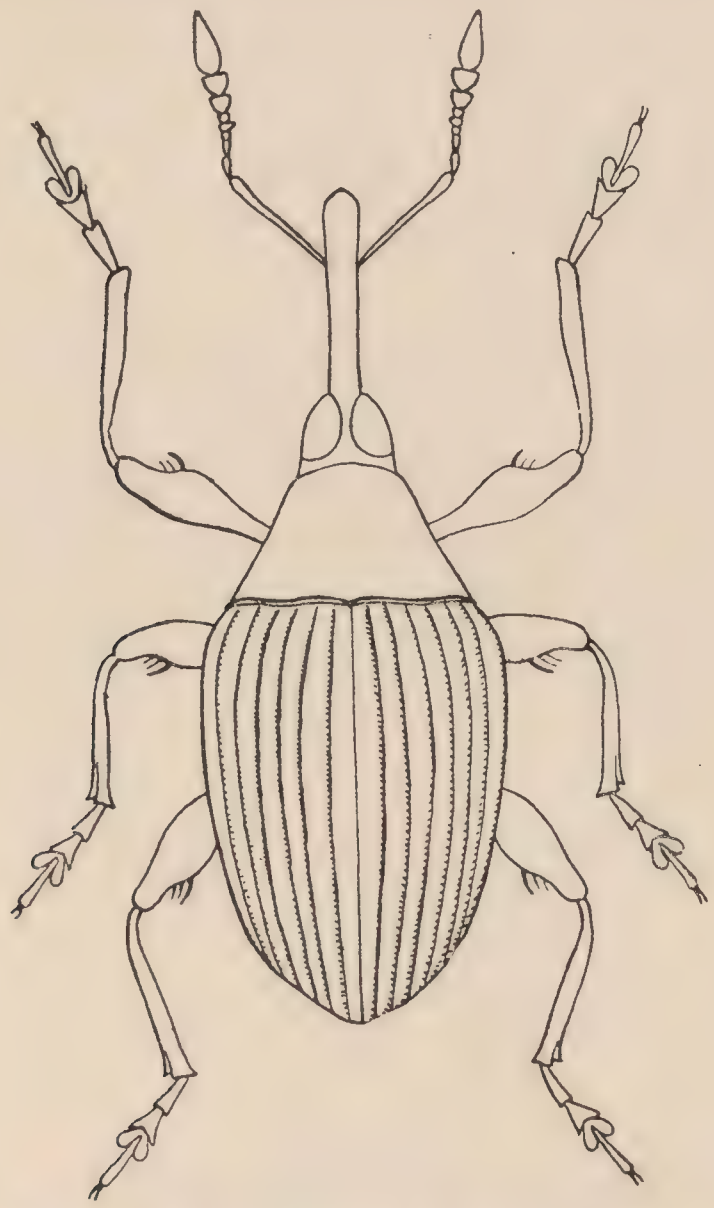

Fig. 2.—*Nanophyes palustris*, sp. n.

aciculate; the hairs fine, fairly long and dense, 4 to 5 abreast on each interval. *Legs* thinly clothed with fine grey hairs; the femora with one large and two small teeth; the tibiae slender, the anterior pairs shallowly sinuate on the posterior face in the apical half.

Length, 2·25–2·5 mm.; breadth, 1·1–1·3 mm.

S. Rhodesia: Salisbury, 4800 ft., v. and vii. 1898, iv. and vii. 1900 (*G.A.K.M.*).

Described from seven specimens.

Nanophyes planifrons, sp. n.

♂. Integument black, with rather sparse, greyish white hairs, but those at the base of intervals 3–5 on the elytra, on the basal half of interval 2 and throughout interval 1, brownish.

Rostrum about as long as the head and pronotum, quite straight from the base to the antennae and then curved downwards, the dorsal outline being on a level with that of the forehead; the antennae inserted rather far back for a male, the apical portion being as long as the scape; the dorsum with the three carinae sharp and smooth and continued well beyond the antennae, but linked together by a narrow transverse ridge between the antennae; the sulci striolate and each bearing a row of minute curved hairs. *Antennae*: length of scape 0·45, funicle 0·30, club 0·42 mm.; joint 4 of funicle strongly transverse. *Prothorax* about two-thirds as long as the basal width, the dorsal outline more convex than in the allied species; the surface moderately shiny, but for the most part very finely aciculate, with short sparse greyish white hairs (shorter than in either of the preceding

species). *Elytra* with the shoulders moderately prominent (intermediate between those of *trochanteratus* and *palustris*); the striae rather deep and with remote shallow punctures, the intervals slightly convex and finely rugulose; the hairs comparatively stout and short, three abreast on each interval in front and two abreast behind. *Legs* thinly clothed with greyish white hairs; the femora with one long and two short teeth; the tibiae slender, the front pair feebly bisinuate internally.

Length, 2·3 mm.; breadth, 1·3 mm.

NATAL: Malvern, vi. 1897 (*G.A.K.M.*).
Described from a single specimen.

Nanophyes probus, sp. n. (Text-fig. 3.)

♂ ♀. Integument black, thinly clothed with white hairs, except for a large indistinct basal patch on the elytra (extending at the base to stria 4) and the whole of interval 1, on which the hairs are brown; the antennal scape piceous with the apex paler.

Rostrum a little longer than the head and pronotum, of about the same length in the two sexes, straight in the basal half and then gently curved; the apical portion distinctly

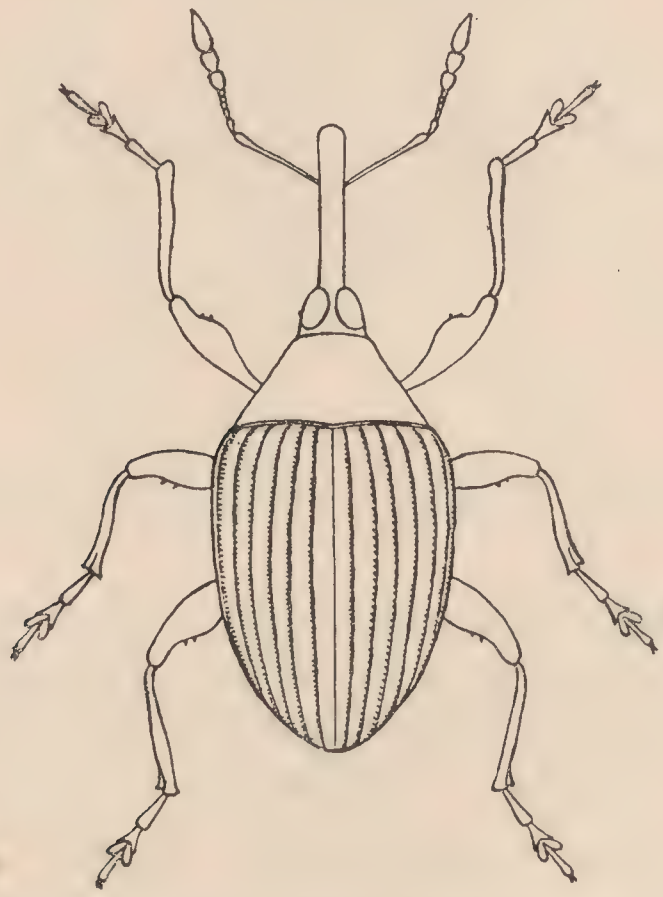

FIG. 3.—*Nanophyes probus*, sp. n.

shorter than the scape; the dorsum tricarinate on the basal portion, but the outer carinae distinct only anteriorly, becoming obsolete towards the base; the apical area shiny and sparsely punctate in the ♀, more opaque in the ♂. *Antennae*: length of scape 0·42, funicle 0·21, club 0·42 mm.; fourth joint of funicle transverse, but not broader than fifth. *Prothorax* only as long as half the basal width, sloping rather more steeply in front than usual, the dorsal outline being gently convex; the surface rather shiny and thinly clothed with fine white hairs that arise from shallow transverse lunate impressions. *Elytra* with the shoulders moderately prominent, the striae containing remote shallow punctures, and the intervals feebly convex and almost smooth; the hairs fine and not completely recumbent, about three abreast on each interval. *Legs* with sparse raised white hairs; the femora with two minute teeth which do not differ greatly in length; the front tibiae scarcely sinuate internally on the apical half.

Length, 1·8 mm.; breadth, 1 mm.

S. RHODESIA: Salisbury, i. 1899, xii. 1904 (*G.A.K.M.*).
Described from two specimens.

Nanophyes deceptor, sp. n.

♂ ♀. Integument black, thinly clothed with whitish hairs, but these mingled with brown ones towards the base on the disk, and those on interval 1 entirely brown; the hairs lie obliquely for the most part, but on the extreme inner edge of intervals 2 and 3 (and sometimes others, especially behind) is a perfectly straight line of longitudinal white hairs, the apex of one almost touching the base of the next; trochanters red-brown and the scape testaceous brown with the club paler.

Rostrum gently curved, a trifle longer in the ♀ than in the ♂ and in both sexes shorter than the head and pronotum together, and comparatively stout, the apical portion being shorter than the scape; the dorsum tricarinate in the basal portion, the furrow externally adjoining the outer carina continued almost to the apex, and the sculpture of the apical area differing but little in the two sexes. *Antennae*: length of scape 0·30, funicle 0·18, club 0·30 mm.; joint 4 of the funicle strongly transverse, but not broader than 5. *Prothorax* nearly two-thirds as long as the basal width, the dorsal outline gently convex, thinly clothed with fine whitish hairs arising from lunate transverse shallow impressions, which sometimes unite to form sinuous transverse lines. *Elytra* with the shoulders hardly prominent, the striae rather deep and with spaced punctures, and the intervals feebly convex and almost smooth (♀) or slightly rugulose (♂), the hairs fine, quite recumbent, three and often four abreast on an interval. *Legs* comparatively short and stout, with the usual recumbent hairs; the femora with two teeth, the inner being much longer than the outer one; the front tibiae not sinuate internally.

Length, 1·6–1·8 mm.; breadth, 0·9–0·96 mm.

S. Rhodesia: Salisbury, vii. 1898, viii. 1900 (*G.A.K.M.*).
Described from a single pair.

Nanophyes importunus, sp. n.

♂ ♀. Integument black; the prothorax with sparse brown hairs on the dorsum, except for a median stripe and a narrow basal band of white hairs, the sides and prosternum with white hairs only; the elytra with brown hairs above as far as stria 6, except for a few white hairs at the base of interval 2 and a large common transverse patch of white hairs about the middle extending to interval 3 on each elytron, and often also a short apical stripe of white hairs on intervals 2 and 4 and a small patch on interval 6 a little behind the shoulder; the entire lateral area of the elytra beyond stria 6 clothed with white hairs right to the apex; the antennal scape piceous with the apex paler; the trochanters and the base of the femora flavous.

Rostrum straight as far as the antennae and then curved gently downwards, a little shorter than the head and pronotum in both sexes and the apical portion much shorter than the scape; the dorsum finely striolate on the basal area, the three very narrow carinae being distinguishable with difficulty on the anterior half only and ceasing a little behind the antennae; the apical area almost similar in the two sexes, shiny, with the usual two dorsal rows of punctures and a shallow furrow on each side. *Antennae*: length of scape 0·42, funicle 0·21, club 0·36 mm.; joint 4 of the funicle asymmetrical, with the lower side produced. *Prothorax* three-fifths as long as the basal width, the dorsal outline almost straight or feebly convex; the surface shiny, with sparse fine hairs arising from shallow transverse curved impressions. *Elytra* with the shoulders rather prominent, the striae fairly deep and with the usual spaced punctures, and the intervals feebly convex, almost smooth but usually finely rugulose towards the base; the hairs fine, quite recumbent, with three rows to an interval. *Legs*: the femora with only two teeth, one being much smaller than the other and very minute; the tibiae occasionally piceous and paler at the base, the anterior pairs feebly bisinuate internally.

Length, 1·4–1·6 mm.; breadth, 0·8–0·9 mm.

S. Rhodesia: Odzi R., x. 1897 (*G.A.K.M.*); Salisbury, vii. and xii. 1899, iv. 1900 (*G.A.K.M.*—type).

Described from ten specimens.

Nanophyes ellipticus, sp. n. (Pl. X, fig. 1.)

♀. Integument black, thinly clothed with grey hairs throughout, except on interval 1 of the elytra on which the hairs are brown; the antennal scape and the trochanters testaceous brown.

Rostrum relatively stout, shorter than the head and pronotum (7 : 8) and evenly curved, the apical portion distinctly shorter than the scape; the dorsum distinctly tricarinate, the carinae smooth and ceasing at a little distance behind the antennae; the apical area shiny, with two abbreviated median rows of shallow punctures and a furrow on each side. *Antennae*: length of scape 0·24, funicle 0·18, club 0·27 mm.; joint 4 of the funicle asymmetrical, broader than 5. *Prothorax* relatively long, the length being two-thirds of the basal width, the dorsal outline distinctly convex longitudinally; the surface quite smooth and shiny, and the hairs fine and sparse. *Elytra* more narrowly elongate than in any other S. African species, the shoulders much reduced, the striae well marked but narrow and with shallow spaced punctures, and the intervals feebly rugulose; the hairs fine, rather long, quite recumbent and forming three rows on each interval. *Legs* with very sparse grey hairs; the femora with only a single minute tooth; the front tibiae not sinuate internally in the apical half.

Length, 1·4 mm.; breadth, 0·7 mm.

S. Rhodesia: Salisbury, iv. 1900 (*G.A.K.M.*).

Described from two specimens.

Nanophyes pumilus, sp. n.

♂. Integument black, very thinly set with grey or light brown hairs; the antennae, tibiae and tarsi piceous.

Rostrum three-fourths the length of the head and pronotum, quite straight and almost porrect in the basal half and gently curved in front; the dorsum tricarinate on the basal portion, but the carinae striolate like the furrows and therefore not easily perceptible except under transverse illumination; the apical area shiny, almost impunctate. *Antennae*: length of scape 0·25, funicle 0·15, club 0·25 mm.; joint 4 of the funicle asymmetrical, broader than 5. *Prothorax* five-eighths as long as the basal width, the dorsal outline slightly convex longitudinally; the dorsum smooth, shiny and very thinly set with short grey hairs. *Elytra* with the shoulders rather prominent, the striae deep and with indefinite distant punctures, and the intervals gently convex, shiny and slightly rugulose; the hairs fine, light brown or grey, and only one or two rows on each interval. *Legs* slender, with very sparse pale hairs; the femora with a single very small tooth; the anterior pairs of tibiae lightly bisinuate internally.

Length, 1·2 mm.; breadth, 0·65 mm.

S. Rhodesia: Salisbury, iv. 1900 (*G.A.K.M.*).

Described from a single specimen.

Nanophyes balteatus, sp. n. (Pl. X, fig. 3.)

♂. Integument black, but the prosternum, a narrow median stripe on the pronotum, a common broad angulate band extending on each elytron from about the middle of the suture to behind the shoulder on interval 6 and a small spot at the base of interval 2, the antennal scape, and the legs (with the tips of the tarsi darker), flavescent. In the cotype (Zululand) the elytral band is narrower and shorter, not extending further than interval 5.

Rostrum as long as the head and pronotum, only slightly curved, the apical portion

half the length of the scape; the dorsum striolate on the basal area, the median carina very narrow, just reaching the antennae and disappearing towards the base, and the lateral carinae obsolescent; the apical area shiny and very feebly punctate. *Antennae*: length of scape 0·36, funicle 0·18, club 0·30 mm. *Prothorax* half as long as the basal width, the dorsal outline almost flat longitudinally; the dorsum smooth, shiny and sparsely clothed with recumbent short white hairs. *Elytra* comparatively elongate, the shoulders moderately prominent, the striae fairly deep and scarcely punctate, and the intervals feebly convex and almost smooth; the hairs short and not entirely recumbent, white, except on a broad band just in front of and another just behind the pale discal band, on which they are brown. *Legs* slender, with sparse pale hairs; the femora with two very small black teeth, the inner one a little longer than the outer.

Length, 1·5 mm.; breadth, 0·78 mm.

S. Rhodesia: Salisbury, vii. 1899 (*G.A.K.M.*—type). Zululand: Eshowe, iv. 1926 (*R. E. Turner*).

Described from two specimens.

Nanophyes eximius, sp. n. (Pl. X, fig. 4.)

♀. General colour of integument pallid testaceous, the prothorax and the characteristic basal triangle on the elytra rather darker; the rostrum red-brown turning to blackish towards the apex; the pronotum with a very large subquadrangular blackish patch on each side, its hind margin nearly reaching the base, its front margin twice as far from the apex, its outer margin on a line with the lateral margin of the elytron and its inner margin deeply sinuate, and a median stripe of dense white hairs running from near the base to the apex; the elytra with a short stripe of white hairs at the base of interval 2; behind this an angulated transverse row of black spots (each covered with dense black hairs), running from the shoulder at the base to the suture at 0·25 mm. from the base, the spots being only on intervals 1, 3, 5, 7; adjoining this behind, a broad oblique band of white hairs, the hairs being denser immediately behind the black spots of the preceding row; then a broader transverse darkish band, narrower at the suture and widening outwardly, due entirely to sparse black hairs, the integument being quite pale; then a transverse row of patches of white hairs on intervals 1, 3, 7, immediately followed by patches of black hairs on intervals 1, 3, 5, 7, and again white on 1, 3, 7; the apical portion of interval 1 with a blackish integumental stripe, interval 3 with two similar blackish spots, and interval 2 with one only, adjoining the upper one on interval 3; antennae flavescent, with the club blackish and paler at the tip; the front femora only with a broad dark ring on a line with the teeth, and the extreme apex also darker.

Rostrum as long as the head and pronotum, straight in the basal half and then gently curved, the apical portion about two-thirds the length of the scape; the dorsum strigulose in the basal area and with three complete narrow carinae, the apical area with the usual two shallow rows of punctures and lateral sulci. *Antennae*: length of scape 0·42, funicle 0·25, club 0·36 mm. *Prothorax* more than half as long as the basal width (4 : 7), the longitudinal outline gently convex, and the surface almost smooth, but with short separated transverse striolae towards the base; the hairs more dense than usual, for the most part concolorous with the underlying integument, except for a few yellowish hairs in the middle of the black patches. *Elytra* with the shoulders rather prominent, the striae deep and indistinctly punctate, and the intervals gently convex and smooth; the hairs much more numerous than usual. *Legs* with rather dense pale hairs; the femora with two unequal teeth, which are larger than in the other pale species; the tibiae slender and simple.

Length, 1·8 mm.; breadth, 1 mm.

S. Rhodesia: Salisbury, vi. 1900 (*G.A.K.M.*).

Described from a single specimen.

Nanophyes pardus, sp. n. (Pl. X, fig. 6.)

♂. Integument generally testaceous yellow, the prothorax rather darker, the rostrum entirely brown, and all the femora with a dark brown subapical ring; the pronotum with a median stripe of dense white hairs from near the base to the apex, and on each side two blackish stripes, the inner one being narrowly divided in the middle; the elytra with the following dark spots in the integument: a transverse sub-basal row just like that in *N. eximius*, sp. n.; then a similar parallel row of much smaller spots, having the sutural spot at about the middle; another similar row behind the middle, having the spots intermediate in size between those of the first two rows; and finally a subapical irregular row of similar spots, but only on intervals 1, 3, 5; rather indefinite rows of patches of white hairs between the rows of black spots, and interval 2 with a short basal stripe of white hairs.

Structurally this species is very close to *N. eximius*, but differs in the following respects:—Apart from sexual differences, the rostrum is markedly stouter and the basal area appears to be striolate all over, the carinae being extremely narrow and much abbreviated; the hairs on the pronotum are less dense; and the shoulders of the elytra are less prominent.

Length, 1·8 mm.; breadth, 0·95 mm.

Natal: Malvern, vi. 1897 (*G.A.K.M.*).
Described from a single specimen.

Nanophyes errans, sp. n. (Pl. X, fig. 2.)

♂♀. Integument very pale testaceous yellow; the head with a blackish patch on each side; the rostrum usually infuscated in the basal half and sometimes entirely so; the prothorax with two broad abbreviated blackish dorsal stripes (rarely obsolescent) and a pleural one on each side; the elytra with the usual darker basal triangle with variable blackish markings on its posterior margin (sometimes forming a complete angulated band, sometimes macular, and very rarely obsolescent), a small elongate blackish spot about the middle of interval 3 (often obsolete), and with the apical half of interval 1 usually slightly darkened; the meso- and metasternum usually blackish, and sometimes also the two basal ventrites.

Rostrum as long as the head and pronotum (♂) or slightly longer (♀), straight from the base to the antennae and then gently curved; the apical portion being two-thirds the length of the scape in ♂ and about four-fifths in ♀; the posterior portion finely shagreened and narrowly tricarinate, the carinae disappearing before the base. *Antennae*: length of scape 0·43, funicle 0·21, club 0·33 mm.; joint 4 of the funicle subquadrate. *Prothorax* about half as long as its basal width, sloping steeply forwards, slightly convex longitudinally, quite straight at the sides, shiny, and thinly set with stout recumbent white hairs. *Elytra* with the shoulders rather prominent, the striae deep and shallowly punctate, the intervals smooth and gently convex; the hairs stout and somewhat raised, about three across an interval, dark on the darker areas and pale elsewhere, except behind the middle of the disk where there are very variable patches of dark hairs. *Legs* entirely pale yellow, with sparse pale hairs; the femora with two minute unequal teeth.

Length, 1·6–1·7 mm.; breadth, 0·75–0·80 mm.

Cape Province: Wynberg, xi. 1905 (*G.A.K.M.*); Cape Town, i. 1926 (*R. E. Turner*); Table Mt., 1906 (*W. Bevins*—type); Ceres, ii. 1921 (*R. E. Turner*); Worcester, iii. 1921 (*Turner*). Natal: Malvern, vi. 1897 (*G.A.K.M.*) Frere, viii.–x. 1892 (*G.A.K.M.*). S. Rhodesia: Salisbury, vii. 1899 (*G.A.K.M.*); Umtali, 25. x. 1897 (*G.A.K.M.*).

Described from eighteen specimens.

Nanophyes turneri, sp. n.

♂. Integument testaceous yellow with blackish-brown markings; the rostrum with a blackish dorsal stripe on each side from the base to beyond the middle; the prothorax more brownish, with two indistinct brownish-black dorsal stripes and on each side a large brownish-black patch in the basal half; the elytra with a common angulated sub-basal macular blackish band, the spots on the intervals in order of length: 1, 3, (2, 5), 4, 7, that on interval 1 being furthest from the base; an elongate blackish spot about the middle on interval 3, a longer one just behind it on interval 1, and a submarginal dark stripe from the base to beyond the middle; the underside entirely testaceous yellow.

Rostrum forming a low angle with the forehead, slightly longer than the head and pronotum, almost straight for about three-fourths of its length and then gently curved; the antennae inserted at about one-fourth from the apex, the ante-antennal portion of the rostrum being less than half as long as the scape; the dorsum tricarinate, the carinae not quite reaching the base, and with four regular rows of recumbent white hairs from the base of the antennae. *Antennae* brown, with the last joint of the club rather darker; length of scape 0·54, funicle 0·22, club 0·48 mm.; joint 4 of the funicle transverse and asymmetrical, and the two basal joints of the club much longer than broad. *Prothorax* a little more than half as long as its basal width, almost flat longitudinally and sloping much less steeply than in *N. errans*; with the sides very slightly sinuate anteriorly, shiny, and sparsely covered with recumbent white hairs. *Elytra* rather elongate, widest at the shoulders, somewhat rapidly narrowed behind, and with the sides almost straight for some distance; the striae rather shallow and shallowly punctate; the subrecumbent hairs rather long and stout, white on the pale and brown on the dark parts, except that they are dark on the apical portions of intervals 1 and 3, and white on the dark lateral stripe. *Legs* very elongate and entirely pale testaceous yellow, with sparse white hairs; the femora with two small dark unequal teeth; the hind tibiae with a rather strong mucro.

Length, 1·9 mm.; breadth, 0·9 mm.

ZULULAND: Eshowe, 1 ♂, vii. 1926 (*R. E. Turner*).

Nearly allied to *N. errans*, sp. n., but in addition to the characters given in the key, it differs in being rather larger and distinctly more elongate; the prothorax is proportionately a little longer, much less sloping in front, and less convex longitudinally; the elytra are more elongate and more strongly narrowed behind; and the hairs are longer and rather more sparse.

Nanophyes bevinsi, sp. n. (Pl. X, fig. 7.)

♀. Integument entirely pale testaceous brown, only the metasternum, the apex of the rostrum, the extreme basal margin of the elytra, the apical fringe of the tibiae, and the tips of the tarsal claws, blackish; the prothorax with all the hairs yellowish white; the elytra with a basal patch and a short apical stripe of similar hairs on intervals 2 and 4, and an irregular oblique stripe from near the base of interval 4 to the middle of the suture and the whole lateral area beyond stria 5 with yellowish white hairs, the remaining spaces being clothed with brown hairs.

Rostrum as long as the head and pronotum, evenly curved, the apical portion nearly as long as the scape; the dorsum with three smooth carinae from the base nearly to the antennae, the apical area shiny, with two rows of coarse elongate punctures and a shallow punctate furrow on each side. *Prothorax* a little longer than half the basal width (7 : 12), quite smooth and shiny, the longitudinal outline being slightly convex; the hairs fine, a little more sparse on an indefinite stripe on each side of the disk. *Elytra* ovate, with the shoulders but little prominent, the striae rather broad and apparently impunctate, and the intervals convex and smooth; the hairs three or four abreast on the intervals,

the pale ones stouter than the dark. *Legs* with a single minute black tooth on the femora, that on the front pair being reduced to a mere black dot; the tibiae slender and simple.

Length, 1·6 mm.; breadth, 0·85 mm.

Cape Province: Table Mt., 1906 (*W. Bevins*).
Described from a single specimen.

Nanophyes wahlbergi, Boh.

♂. Integument entirely pale testaceous brown, only the eyes and claws being black; the pronotum sparsely clothed with stout yellowish-white subrecumbent hairs; the elytra with similar hairs disposed thus: a small spot at the base of interval 2, an oblique stripe from the shoulder to the middle of the suture, a less oblique macular band just behind it reaching only to stria 2, numerous indefinite elongate patches (more or less confluent) on the posterior declivity, and a sparse marginal stripe; the remaining darker areas clothed with brown hairs that are difficult to distinguish; on the disk the integument beneath the whitish hairs is paler than elsewhere.

Head rather long, conical, thinly clothed with whitish hairs; the forehead rather broad, wider than the apex of the antennal scape. *Rostrum* almost as long as the head and prothorax together, almost straight as far as the antennae (inserted a little beyond the middle) and there gently curved; the surface very finely aciculate and dull, very thinly clothed with fine pubescence, the basal portion with a low median carina and a very shallow furrow on each side of it, the apical portion with irregular rows of rather large shallow punctures. *Antennae*: length of scape 0·36, funicle 0·31, club 0·29 mm.; fourth joint of the funicle asymmetrical, produced internally, broader than 5. *Prothorax* conical, with the sides quite straight, the median length two-thirds of the basal width, the dorsal outline only slightly convex; the dorsum moderately shiny, with rather indefinite shallow punctures; the hairs rather stout and not lying quite flat. *Elytra* rather narrowly ovate, broadest about the middle, narrow at the shoulders. the humeral calli not projecting laterally; the striae rather deep, with indefinite shallow punctures, the intervals gently convex, shiny, and feebly rugulose; the pale hairs comparatively stout, only subrecumbent, usually two and occasionally three abreast on an interval. *Legs*: the femora with three strong teeth, the inner one much longer than the others, those on the hind pair smaller than the others; the tibiae simple.

Length, 1·9 mm.; breadth, 0·9 mm.

Natal: Durban (*J. Wahlberg*). Cape Province: Milnerton, Cape Town, xii. 1925 (*R. E. Turner*).

The foregoing description was made from the type, which was kindly lent to me by my friend Prof. Dr. Y. Sjöstedt, of the Stockholm Museum. Subsequently Mr. R. E. Turner sent 1 ♂ and 2 ♀♀ to the British Museum, from Cape Town, which seem to be certainly referable to this species. The male differs only in having the second band of white hairs on the elytra extended outwards and widening to stria 7. In the females the hairs all over are distinctly finer than in the males, on the disk of the pronotum there are some dark hairs intermingled with the pale ones, and on the elytra the patches of white hairs behind the oblique humeral band form more regular transverse macular bands.

Nanophyes concolor, sp. n.

♂♀. Integument uniform testaceous brown, except that the eyes, basal margin of elytra, and the tarsal claws are black, as usual; evenly and rather sparsely clothed throughout with somewhat short, subrecumbent white hairs.

Rostrum forming a slight, but distinct, angle with the forehead, slightly shorter (♂)

or a little longer (♀) than the head and prothorax, gently curved, with the antennae inserted at about the middle in both sexes, so that the apical portion is as long as the comparatively short scape; the dorsum indistinctly tricarinate in the basal half. *Antennae* short, the scape and club being unusually short in proportion to the funicle; length of scape 0·25, funicle 0·25, club 0·21 mm.; joint 4 of the funicle slightly transverse; the two basal joints of the club nearly as long as broad. *Prothorax* comparatively short, about as long as three-fifths of the basal width, quite straight at the sides, gently convex longitudinally, and the forward slope not very steep. *Elytra* ovate, widest about the middle, with the shoulders only slightly prominent; the striae rather deep, but shallowly punctate, the intervals feebly convex. *Legs* comparatively short and stout; the femora strongly clavate, especially the front pair, and with one long tooth and another very small one.

Length, 1·4–1·5 mm.; breadth, 0·8–0·86 mm.

Cape Province: Ceres, 1500 ft., 1 ♂, 1 ♀, i. 1921 (*R. E. Turner*).

Its uniform testaceous-brown colour, and the position and proportions of the antennae should make this species easily recognisable.

Nanophyes pulicoides, sp. n.

♂. Integument uniform testaceous brown, the basal margin of the elytra and the club of the antennae darker, and the eyes and claws black; uniformly and sparsely clothed with very short, quite recumbent, pale hairs.

Much like a very small specimen of *N. concolor*, sp. n., but differing principally as follows:—*Head* with the eyes quite flat, not forming an angle with the outline of the head posteriorly, as they do in *concolor*; the forehead forming a much lower angle with the rostrum and broader than usual, being rather wider than the club of the scape. *Rostrum* with the antennae inserted a little beyond the middle; length of scape 0·22, funicle 0·16, club 0·18 mm.; joint 4 of the funicle transverse and asymmetrical; the club much more compact than usual, the two basal joints distinctly transverse. *Legs* with only one femoral tooth, the other being reduced to a minute setigerous granule.

Length, 1·0 mm.; breadth, 0·6 mm.

Cape Province: Worcester, 1 ♂, iii. 1921 (*R. E. Turner*).

Nanophyes blandus, sp. n.

♂ ♀. Integument uniform red-brown, except the extreme basal margin of the elytra and the tips of the femoral teeth, which are blackish; the pronotum sparsely clothed with rather long white hairs and a few brownish ones on the middle of the disk; the elytra covered mostly with similar hairs, and with an indefinite common curved subbasal darker band formed of brown hairs, and a similar one behind the middle, both bands terminating on stria 5; the antennae unicolorous testaceous yellow.

Rostrum as long as (♀) or a little shorter than (♂) the head and pronotum, continuously curved, the apical portion shorter than the scape; the dorsum with three smooth carinae on the basal area, the two intervening sulci shallowly punctate, the outer ones continued well beyond the antennae. *Antennae*: length of scape 0·4, funicle 0·3, club 0·3 mm.; the three apical joints of the funicle as long as or slightly longer than broad, joint 4 simple. *Prothorax* a little longer than half its basal width (4 : 7), shiny and sparsely aciculate, its longitudinal outline slightly convex. *Elytra* with the humeral elevation obsolete, the striae rather shallow and indistinctly punctate, and the intervals almost flat and smooth; the hairs recumbent and forming up to four rows to the interval. *Legs* with one large and two small teeth on the femora; the tibiae simple, with the apical fringe of the posterior pairs dark.

Length, 1·75–1·85 mm.; breadth, 0·95–1·1 mm.

S. Rhodesia: Bulawayo, xii. 1903 (*G.A.K.M.*—type); Odzi River, x. 1897 (*G.A.K.M.*).

Described from two specimens.

Nanophyes indignus, sp. n.

♀. Very similar to *N. blandus*, sp. n., the hair pattern on the elytra being the same, but the general colouring is of a much darker brown, the metasternum blackish, and the club of the antennae darker than the rest. The apical part of the rostrum is proportionately longer, being as long as the scape, and is more finely and sparsely punctate; the first (basal) joint of the club is much broader, being as broad as the middle one, whereas in *N. blandus* it is little more than half as wide; and the hairs on the elytra are appreciably shorter.

Length, 1·5 mm.; breadth, 0·9 mm.

Natal: Frere, vii. 1892 (*G.A.K.M.*).

Described from a single specimen.

Nanophyes armatus, Boh.

N. armatus, Boheman, Schönh. Gen. Curc. iv, 1838, p. 781.

This common and well-known species is widely distributed throughout South Africa; I have before me twenty-four specimens from the following localities:—

Cape Province: Algoa Bay (*Dr. H. Brauns*); Port Alfred (*Rev. J. A. O'Neil*); Uitenhage, on Acacia, xi. 1901 (*O'Neil*); Queenstown, 3500 ft., i.–ii. 1923 (*R. E. Turner*). Pondoland: Port St. John, xi. 1923 (*Turner*). Natal: Malvern, x. 1897 (*G.A.K.M.*); Estcourt, i. 1899 (*Dr. F. Dimock Brown*); Ennersdale, on Acacia, xi. 1892 (*G.A.K.M.*); Frere, iii. 1896 (*G.A.K.M.*). S. Rhodesia: Salisbury, on Acacia, x. 1898, ii. 1899 (*G.A.K.M.*); Umtali, xi. 1897 (*G.A.K.M.*).

Nanophyes nasalis, sp. n. (Pl. X, fig. 5.)

♂♀. Integument chestnut-brown dorsally, turning to blackish on the sides of the thorax and elytra, the prothorax being usually rather paler; the rostrum black or brownish black; the antennae light testaceous brown, with the apical joint of the club blackish; the legs light testaceous brown, with an indefinite blackish streak on the apical half of the dorsal edge of the femora and a blackish ring on the basal half of the tibiae; the pronotum with fairly dense yellowish hairs, varied with a few whitish and brown ones; the elytra with intermingled yellowish and whitish hairs, the former often predominating on the basal half of the disk and the latter towards the sides and apex; each elytron with a very oblique subbasal row of elongate patches of black hairs on intervals 1, 3, 5, 7, that on 7 being close to the base and that on 1 at 0·75 mm. from the base; just behind and parallel with this an indefinite oblique stripe of whitish hairs, and behind this again a short stripe of black hairs on the suture.

Rostrum of ♂ as long as, of ♀ much longer than (3 : 2), head and pronotum, almost straight in the basal half, then very gently curved; the antennae inserted only a little in front of the middle in the ♀, the apical portion being as long as the scape, whereas in the ♂ it is only half the length of the scape; the dorsum with four sulci, the inner pair interrupted between the antennae, the basal part being striolate and the apical punctate, the outer deep and punctate throughout; in the ♂ the inner sulci are obsolete towards the base, which is entirely striolate, the course of the sulci marked throughout by rows of pale hairs, which are much more conspicuous in the ♂ than in the ♀. *Antennae*: length of scape, ♂ 0·66, ♀ 0·85; funicle, ♂ 0·42, ♀ 0·54; club, ♂ 0·42, ♀ 0·48 mm.; joints 3 and 4 of the funicle longer than broad and simple, 5 quadrate. *Prothorax* longer than half the basal width (3 : 5), the anterior slope much less steep than usual, and the longitudinal outline

distinctly convex; the surface with very shallow confluent punctation on the disk, becoming fine and sparse at the sides, and the hairs rather long and coarse. *Elytra* with the shoulders much reduced, a shallow transverse impression close to the base, and the scutellar area flattened as far as stria 2; the striae narrow and with shallow spaced punctures, the intervals flat, smooth or very feebly punctulate; the hairs long and coarse, not absolutely recumbent, there being up to 5 or 6 across an interval. *Legs* with four sharp teeth on the femora, the innermost one being very long and the others diminishing outwardly; the tibiae simple, with the apical fringes brown.

Length, 2–2·9 mm.; breadth, 1–1·6 mm.

S. Rhodesia: Odzi River, x. 1897; Lesapi River, xi. 1897; Salisbury, xii. 1897, ix.–x. 1900 (*G.A.K.M.*—type).

Described from seventeen specimens.

Nanophyes achillei, Pic.

N. achillei, Pic, Mélanges, viii, 1913, p. 3.

" Oblongus, nitidus, griseo pubescens, rufo-testaceus, pectore pro parte nigro-piceo, elytris testaceis, brunneo notatis.

" Oblong, brilliant, revêtu d'une pubescence grise, longue, roux testacé avec la poitrine tachée de noir de poix et les yeux noirs, élytres testacés, ornés des dessins bruns suivants : une fascie oblique derrière l'écusson, plusieurs petites macules sur la suture. Rostre long, arqué, caréné à la base; antennes à massue de 3 articles distincts et épais; prothorax relativement long, un peu rétréci en avant; élytres pas très courts striés; cuisses épaisses, antérieures multidentées. Long, 2 mill. environ. Le Cap. (*A. Raffray.*)

" Peut se placer près de *N. armatus*, Boh., mais sa coloration est tout autre et sa forme un peu différente."

The colouring does not agree with that of any South African *Nanophyes* known to me, but the species might prove to be the same as that described below as *Phoroctenus oneili*, sp. n.

Genus **AMPHIBOLOCORYNUS,** Schh. 1847.

The only species known at present is the genotype.

Amphibolocorynus varius, Lac. 1863, Fhs. 1871.

Fåhraeus' type agrees well with specimens that I have from Natal, from which the Cape Province examples differ constantly in minor characters.

Natal: Estcourt, under bark, ix. 1892 (*G.A.K.M.*); Howick, i. 1899 (*Dr. F. Dimock Brown*).

A. varius pallidus, subsp. n.

In the typical form the colour of the derm is dark brown, very indefinitely mottled with blackish-brown, the elytra being clothed with dense, recumbent, light brown hairs, variegated with dark brown ones and a few whitish ones; whereas in the present subspecies, which is distinctly smaller, the colour is uniformly yellowish-brown, with sometimes a short darker brown stripe on the elytra at the base of interval 3, and the hairs on the elytra are mainly whitish, with light brown hairs predominating on intervals 4 and 5 and across the top of the declivity.

Length, 2·5–3·0 mm.; breadth, 1·25–1·50 mm.

Cape Province: Uitenhage, on *Acacia Podocarpus*, and on bramble, x. 1898 (*Rev. J. A. O'Neil*).

Described from thirteen specimens.

Genus **PHOROCTENUS,** nov.

Head (as seen from below) globular, the eyes being but little raised above the surface; the forehead at its narrowest about as broad as the club of the scape, its outline forming a steep angle with that of the rostrum. *Rostrum* elongate, strongly curved, subcylindrical; the scrobes entirely lateral, deep and continued to the eyes; the mandibles directed obliquely upwards, not much incurved, with three teeth (the two lower ones very long) which apparently meet the opposing teeth and do not interlock, and with an outwardly projecting tubercle on the external inferior edge near the base. *Antennae* with the funicle 5-jointed, the joints elongate and the 4th not asymmetrical; the club with three separated joints, the apical one being longer than the other two together. *Elytra* oblong-ovate, the shoulders feeble and very oblique; interval 8 with a row of minute granules on the basal third. *Legs* comparatively stout; the femora strongly clavate, with the usual fine teeth, the inner one being much the longest; the tibiae dilated towards the apex, with the upper angle of the corbel produced into a sharp tooth. *Sternum* with the front coxae touching the anterior margin of the prosternum, the mid coxae almost as widely separated as the hind pair; the metasternum between the posterior pairs of coxae hardly as long as the mid coxae.

Genotype, *Phoroctenus oneili,* sp. n.

Phoroctenus oneili, sp. n. (Pl. X, fig. 8.)

♂. Integument pale testaceous brown, the rostrum with the basal half darker, the prothorax with two transverse dark marks at the base and a large indefinite blackish patch on each side, the elytra with a large ill-defined pentagonal scutellar blackish patch, extending on each side to stria 3 and along the suture to 0·6 mm. from the base, and a darker marginal stripe on the basal half; the prothorax with mingled yellowish and whitish hairs; the elytra with brownish hairs on the scutellar markings and on small basal patches on intervals 5 and 7, elsewhere with whitish hairs, but intervals 1, 3, 5, 7 faintly tessellated with spots of yellowish hairs; the antennae either entirely testaceous or with the basal two-thirds of the last joint of the club blackish; the legs testaceous, the femora with an indefinite dark patch, which is largest on the front pair and diminishes on the posterior ones.

Rostrum longer than the head and pronotum (4 : 3), strongly curved, with the antennae inserted only a short distance in front of the middle, the apical portion being as long as the scape; the dorsum with four punctate sulci, the median pair ceasing at the antennae and continued as two rows of punctures, the outer ones extending almost to the apex. *Antennae*: length of scape 0·54, funicle 0·43, club 0·48 mm.; joints 1–4 of the funicle longer than broad, 2 equal to 3, and 5 as long as broad. *Prothorax* slightly longer than half the basal width, the dorsum with confluent shallow punctures; the hairs stout and sufficiently dense as almost to conceal the sculpture, gathered into an incipient tuft on each side about the middle, giving the appearance of a faint angulation. *Elytra* oblong-ovate, rather broadly rounded behind, and slightly flattened on the scutellar patch; the striae not very clearly visible owing to the dense hairs, shallow and feebly punctate, and each containing a single row of recumbent white setae; the intervals flat and smooth. *Legs* with three femoral teeth.

Length, 2·4–2·75 mm.; breadth, 1·3–1·5 mm.

Cape Province: Uitenhage, ii. 1904 (*Father J. A. O'Neil*—type). S. Rhodesia: Bulawayo, xii. 1903 (*G.A.K.M.*).

Described from six specimens. The single example from Bulawayo is appreciably smaller than the others and the general colour of the integument much darker, so that the tessellation of the elytra shows up more clearly,

giving the insect a very distinctive appearance; but as no structural difference can be observed, it is here treated merely as a variation of the southern species.

Phoroctenus luteus, sp. n.

♀. Integument entirely pale testaceous brown, the antennae and legs concolorous, only the extreme apex of the rostrum and the tips of the femoral teeth darker; the dorsum clothed with fairly dense golden-yellow hairs, which become whitish on the lower surface and legs.

Rostrum (measured across the curve) much longer than the head and pronotum (12 : 7), the antennae inserted distinctly behind the middle; the dorsum smooth and shiny, with four rows of punctures which are continued to the apex, but the punctures on the apical portion finer and much more widely spaced than those on the basal. *Antennae*: length of scape 0·66, funicle 0·42, club 0·48 mm.; all the joints of the funicle longer than broad, and 2 longer than 3. *Prothorax* a little longer than half the basal width, very slightly rounded at the sides, the disk finely rugulose, and the hairs stout and fairly dense, being denser and slightly raised in a small patch on each side about the middle. *Elytra* as in *Ph. oneili* but broader, and with a patch of slightly denser concolorous hairs near the base of intervals 3, 5, 7. *Legs* with three femoral teeth.

Length, 2·8–3 mm.; breadth, 1·5–1·6 mm.

Cape Province: Uitenhage, ii. 1901, iii. 1904 (*Father J. A. O'Neil*).
Described from five specimens.

Genus **HEXATMETUS,** nov.

Head ovate, the forehead forming more or less of an angle with the rostrum. *Rostrum* curved, elongate, subcylindrical; the scrobes entirely lateral and continued to the eyes; the mandibles tridentate. *Antennae* with the scape slender and abruptly clavate, exceeding the front margin of the eye, the knob bearing the usual two setae above and one beneath; the funicle 6-jointed; the club with the two basal joints separated and together as long or nearly as long as the remainder. *Prothorax* subconical, rather more elongate than usual in the subfamily, with the sides straight; the base gently arcuate, carinate and with the usual row of minute stout oblique dark setae. *Elytra* subovate or subpyriform, with the external basal angle not produced, widest at or behind the middle, with the sparse erect setae on the alternate intervals more numerous and more conspicuous than in *Nanophyes*; the base with the usual granular elevated margin. *Wings* absent. *Legs* elongate, as in *Nanophyes*; the femora with one long tooth and one to three smaller ones; the tarsal claws connate. *Sternum*: the prosternum with the front coxae touching the anterior margin; the median coxae narrowly separated, the space between them being only about one-third as broad as that between the hind coxae; the metasternum between the coxae half as long as the median coxae or less.

Genotype, *Nanophyes pusio*, Boh. 1859.

In spite of their close general resemblance to *Nanophyes*, the species of this genus may be readily distinguished by the 6-jointed funicle and the absence or extreme reduction of the humeral calli, which is correlated with the complete absence of the true wings; moreover in *Nanophyes* the scape does not exceed the front margin of the eye, the external basal angle of the elytra is produced downwards, the metasternum between the coxae is as long as the median coxae, and the space between the median coxae is, at least, more than half as broad as that between the hind coxae.

So far as is known at present, *Hexatmetus* appears to be restricted to the Cape Province. I have seen a fair number of specimens collected on Table Mountain by Mr. W. Bevins, and others from Mossel Bay, George and Ceres,

collected by Mr. R. E. Turner. But the species appear to be very difficult to discriminate, and for the present only the following one will be described.

Hexatmetus quadrinotatus, sp. n. (Pl. X, fig. 9.)

♂ ♀. Integument testaceous brown; the pronotum sometimes with two large indefinite longitudinal patches of dark brown; the elytra with the lateral margins dark brown and with a common ill-defined dark brown discal patch, extending to stria 3 near the base, narrowing to stria 1 about the middle and abruptly widening to stria 4 behind the middle; the basal area between striae 4 and 7, usually a small patch before the middle on interval 4, and an elongate patch at the base and another about the middle on interval 2, all clothed with white hairs, the hairs being brown elsewhere; the sides of the meso- and metasternum clothed with dense white hair-scales.

Rostrum as long as or a little longer than the head and pronotum, slightly curved and with the antennae well beyond the middle (♂) or strongly curved and with the antennae only slightly beyond the middle (♀); the basal portion with three feeble carinae, the apical part with four irregular rows of subconfluent punctures. *Antennae* testaceous with the club darker; the joints of the funicle in order of length: 1, (2, 3), (4, 5), 6, joints 2 and 4 being narrower than the others and 5 asymmetrical and broader than 6, which is transverse. *Prothorax* with the length to the basal width as 17 : 22, set with shallow punctures and rather thinly clothed with recumbent white hairs, except on two elongate discal patches (corresponding approximately with the dark brown patches when present) on which the hairs are brown. *Elytra* ovate, with very feeble humeral calli in ♂ and none in ♀; the striae well marked and distinctly punctate, the intervals slightly convex; the white hairs much stouter than the dark ones. *Legs* elongate, testaceous, with the thickened part of the hind femora sometimes darkened; the tibiae with one rather long stout tooth and two much smaller ones.

Length, 1·6–1·9 mm.; breadth, 0·8–0·9 mm.

Cape Province: Table Mt., 1 ♀, 2 ♂♂, 1916 (*W. Bevins*).

It is not absolutely certain that the male cotypes are rightly associated with the female type, but it seems highly probable that the differences in the curvature of the rostrum and the development of the humeral calli on the elytra are only sexual in character.

The genotype, *H. pusio*, Boh., is a still smaller insect (1·2 mm. long), which is thinly and uniformly clothed above with fine subrecumbent white hairs. Although Boheman describes the femora as having only one small tooth, there is actually in the type another minute tooth beyond it; and in a specimen which I take to be a male of this species there is a second minute tooth on only three of the femora. Mr. W. Bevins took one male and one female of this species on Table Mountain.

Explanation of Plate X.

Fig. 1. *Nanophyes ellipticus*, sp. n.
2. ,, *errans*, sp. n.
3. ,, *balteatus*, sp. n.
4. ,, *eximius*, sp. n.
5. ,, *nasalis*, sp. n.
6. ,, *pardus*, sp. n.
7. ,, *bevinsi*, sp. n.
8. *Phoroctenus oneili*, gen. et sp. n.
9. *Hexatmetus quadrinotatus*, gen. et sp. n.

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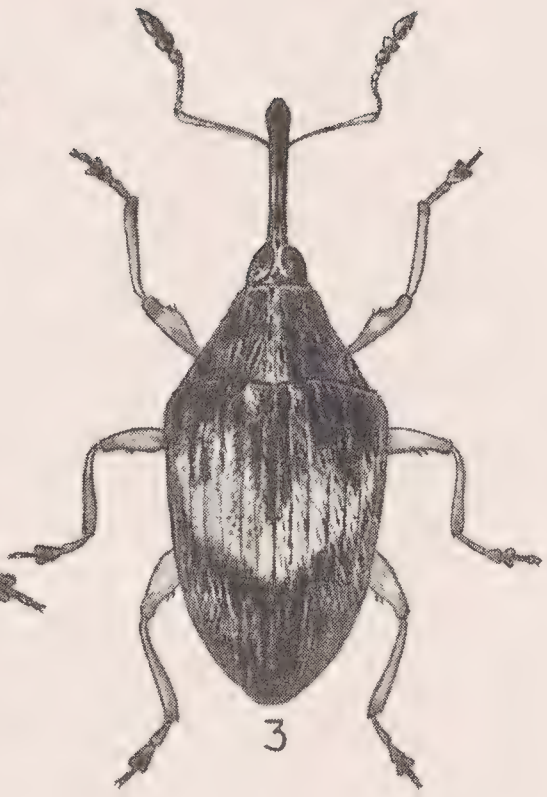
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NEW SOUTH AFRICAN NANOPHYINAE.

DESCRIPTIONS DE CERCOPIDES NOUVEAUX PROVENANT DE LA COLLECTION DU BRITISH MUSEUM

Par le Dr. V. Lallemand, Uccle, Belgique.

(Communicated by N. D. Riley.)

[Read March 2nd, 1927.]

Sous-famille Machaerotinae.

1. **Chaetophyes ceramensis,** sp. nov.

Élytres bruns s'éclaircissant vers l'extrémité et y devenant transparents; ailes transparentes, à nervures brunes; tête, pronotum, écusson, sternum, jaunes; sur le front, une large bande noire s'étendant jusqu'à la base des élytres, en passant par la partie inférieure de l'œil et le bord du prothorax; pattes jaunâtres, sauf les tarses et les tibias postérieurs, bruns; abdomen jaune-brunâtre.

Longueur totale, 7 mm.; longueur du corps, 5·5 mm.

Habitat : Ceram (*E. Streseman*).

Espèce voisine de *C. bicolor* Schmidt, s'en distingue principalement par la coloration générale, et la bande transversale noire du front.

2. **Chaetophyes vicina,** sp. nov.

Ressemble beaucoup à *C. bicolor*, Schmidt, même coloration jaune du vertex, de l'écusson, pronotum jaune-vert, à bords antérieur et latéraux, jaunes; mais front, clypeus, sternum, pattes, face supérieure du premier segment abdominal et un bord étroit des segments abdominaux, jaunes; tibias légèrement teintés de brun; milieu du mésosternum et abdomen, noirs; ailes hyalines à nervures brunes; élytres bruns, pouvant varier d'un brun assez clair au brun-noir, des taches plus ou moins transparentes, voire même presque hyalines peuvent s'y montrer, ainsi qu'une tache jaunâtre entre le cubitus et le bord costal.

Longueur, 5 à 6 mm.

Habitat : New South Wales, Maree, 5.xii.1917.

Types : collection du British Museum et la mienne.

3. **Chaetophyes bicolor,** Schmidt.

Chaetophyes bicolor, Schmidt, Stett. entom. Zeit., Jahrg. 79, Heft. II, p. 368 (1919).
Polychaetophyes perkinsi, Hacker, Mem. Queensl. Mus., Vol. VIII, Part III, p. 246, fig. 6 (1926).

4. **Machaerota insignis,** sp. nov.

♀. Tête, pronotum, écusson d'un brun légèrement rougeâtre; front à stries latérales ocre-jaune; yeux gris; pronotum à carène médiane plus claire, et sur la partie antérieure de chaque côté deux sillons noirs, parallèles, dirigés en arrière et en dehors, l'un partant derrière l'œil et l'autre près du milieu; à la partie antérieure de l'écusson une grande tache allongée et au bord postérieur une fine ligne blanc-jaunâtre, prolongement ocre-brun; élytres opaques et bruns à la base, jaune-brun et transparents sur tout le restant, à la base du clavus entre la nervure longitudinale et la suture une strie blanc-jaunâtre, nervure périphérique depuis la pointe du clavus jusque près de l'apex de l'élytre ainsi que de gros

grains sur les nervures apicales, bruns; sternum blanc-gris, un peu jaunâtre; pattes brunâtres; tibias postérieurs ocre-jaune, épines brunes; milieu des segments de la face inférieure de l'abdomen brun-noirâtre largement bordés en arrière de blanc-jaunâtre, sur les côtés blanc-jaunâtre une assez grande tache brun-noir; face supérieure brun-noir.

Front lisse au milieu, strié sur les côtés; pronotum à forte et grossière ponctuation, en stries plus ou moins transversales, à forte carène médiane; sur l'écusson fortement ponctué, à la partie médiane, un sillon à bords tranchants, prenant naissance près de la base et s'étendant jusqu'au prolongement, celui-ci est long et dépasse quelque peu l'extrémité des élytres; élytres trois fois aussi longs que larges (6 mm. et 2 mm.), sur le clavus une seule nervure, sur le corium le nombre de cellules situées le long du bord apical varie d'un côté à l'autre : à droite six et à gauche cinq.

Longueur totale, 7·5 mm.

Habitat : Ceram (*E. Streseman*).

5. **Machaerota incerta,** sp. nov.

♀. Brun légèrement rougeâtre; front à milieu noir et à stries latérales jaune-brun; pronotum plus foncé à la partie postérieure; sur l'écusson une grande tache jaunâtre, dirigée en haut et en arrière, partant de l'angle antéro-inférieur et s'étendant jusqu'au milieu, une fine bande blanc-jaunâtre le long du bord postérieur; élytres et ailes d'un jaune légèrement brun, transparents, les premiers ont la base plus foncée et le tiers basal du bord externe brun; tibias postérieurs jaunâtres; abdomen brun-clair légèrement jaunâtre, à la base de la face supérieure une bande jaunâtre; tarière brun-noir.

Bord antérieur du vertex arrondi; une carène sur le pronotum densèment ponctué; sur l'écusson un sillon médian s'étendant sur un peu plus de la moitié de la longueur et parcouru dans toute sa longueur par une fine carène; son prolongement est à peu près de même longueur que les élytres; sur le clavus du côté gauche deux nervures, sur celui de droite une seule. Ce n'est pas le premier individu que je trouve présentant cette dissimilitude de nervation dans les deux élytres, et le genre *Conmachaerota,* Schmidt, basé sur le nombre de nervures du clavus peut-il être maintenu dans ces conditions ?

Longueur, 7 mm.

Habitat : Siamese Malay States, Mabeh Jalor, 23.vii.1901 (*Annandale and Robinson*).

PROMAXUDEA, gen. nov.

Ce genre se caractérise par la forme du pronotum dont les angles latéraux sont saillants, mais contrairement à leur disposition dans le genre *Maxudea,* Schmidt, ils ne sont que légèrement dirigés en haut, et portent une carène dirigée en avant et en dedans; une assez forte carène sur le milieu du pronotum.

Type du genre : *Promaxudea humboldti,* Lallemand.

6. **Promaxudea humboldti,** sp nov.

♀. Front noir, sur les côtés des stries jaune-brunâtre; vertex, pronotum, écusson et son prolongement brun légèrement rougeâtre; sur l'écusson, une ligne courte, allant du bord du sillon jusqu'au bord antérieur, une seconde ligne suivant le bord postérieur en dessous du prolongement, ainsi qu'une tache à la base de celui-ci, blanc-jaune; élytres et ailes hyalins, les premiers ont les nervures jaune-orange; sternum, abdomen, pattes, bruns; tibias postérieurs, sauf la base et l'extrémité, ocre-jaune; une bande jaune à la base de la face supérieure de l'abdomen; sur le pronotum et le sternum une villosité blanc-

argent. Sillon de l'écusson profond, à bords tranchants, parcouru dans presque toute sa longueur par une fine carène; prolongement dépassant les élytres.

Longueur, 7 mm.

Habitat : Malay Archipelago, Humboldt Bay (*W. Doherty*).

Sous-famille Aphrophorinae.

7. **Peuceptyelus minutus,** sp. nov.

Ocre-gris brunâtre, plus clair sur la moitié postérieure et la partie externe des élytres; base de la nervure anale externe, tronc commun du médian et du cubitus, radius sur à peu près sa moitié antérieure, ainsi qu'un trait oblique réunissant ce dernier au médian, immédiatement après sa séparation du cubitus, brun-noir ou noir, puis ces nervures deviennent jaunâtres et enfin brunes à la partie apicale; tête, sternum, abdomen, bruns, plus clairs par places; toutes les cuisses, tibias antérieurs et médians alternativement ocre et brun; tibias postérieurs et organes génitaux ocre.

Toute la surface supérieure densèment ponctuée; ocelles petits, plus près l'un de l'autre que des yeux; une carène sur le vertex et le pronotum; sur les élytres, l'espace compris entre le radius et le bord externe est large, le bord externe est convexe et arrondi, et l'angle apical aigu, à pointe arrondie; front ayant une carène longitudinale médiane, et des stries ponctuées transversales sur les côtés; rostre long s'étendant au-delà des hanches postérieures; une épine sur les tibias postérieurs.

Longueur totale, 5·5 mm.

Habitat : South India, Kodai Kanal (*T. V. Campbell*).

8. **Philagra fusca,** sp. nov.

Brun foncé; face inférieure de l'abdomen, face supérieure du premier article du rostre, second article en entier, extrémité des épines et des tarses postérieurs, moitié apicale du prolongement céphalique, noirs; face supérieure de l'abdomen, base des élytres, bord externe du pronotum et moitié postérieure du bord externe de la tête, scrobes et base des antennes, métasternum, articulations fémoro-tibiales, tibias et tarses postérieurs d'un jaune légèrement brunâtre; extrémité de l'écusson jaune-brun; ailes brunes à base jaune; yeux gris-brun très clair, tachés de brun foncé; toute la face supérieure de l'insecte est recouverte d'une villosité ocre.

Élytres à peu près trois fois aussi longs que larges à bord costal fort arrondi; tête avec son prolongement aussi longue que l'abdomen, le prolongement se dirige en haut et en avant, n'a pas de carène sur les faces supérieure et inférieure; un sillon médian longitudinal sur le pronotum; deux fortes épines sur les tibias postérieurs.

Longueur totale, 16 mm.; longueur de la tête, 5 mm.; élytres : longueur, 11 mm., largeur, 4 mm.

Habitat : Tonkin, Bao Ha, 1923 (*H. Stevens*). (Musée de Londres.) Hanoi (ma collection).

Types : Collection du Musée de Londres, et la mienne.

9. **Clovia incerta,** sp. nov.

Face supérieure de l'insecte gris-jaune-paille, face inférieure un peu plus foncée; scrobes, extrémité du rostre, des épines et des tarses, noirs; nervures des élytres légèrement brunes vers la base; un point brun entre le médian et la branche interne du radius; ailes hyalines; élytres recouverts d'une villosité dorée.

Vertex en angle à peu près droit dont les bords sont légèrement convexes, sa longueur

égale la moitié de la largeur au bord postérieur; sur la partie frontale du vertex, à bords légèrement relevés, une fine carène longitudinale; sur le pronotum trois sillons longitudinaux peu marqués, les bords externes sont très courts, et le postérieur est concave en angle obtus; extrémité des élytres arrondie.

Se distingue du précédent par le vertex moins long, moins aigu; il rappelle *Ptyelus* (*Philaenus*) *lineatus*.

Longueur, 6 mm.

Habitat: South Africa, Cape Province, Aliwal North, December 1922 (*R. E. Turner*).

10. **Clovia intermedia,** sp. nov.

Gris-jaune-paille, à peu près uniforme; nervures légèrement brunes spécialement chez le ♂; une fine ligne parallèle au bord supérieur du front, une large bande s'étendant d'une hanche antérieure à l'autre, en passant par la partie inférieure du front, une tache sur le mésosternum au devant des hanches médianes, extrémité du rostre, des épines et des tarses, noires; un point brun-noir vers la fin du second tiers des élytres, réunissant la branche interne du radius et le médian.

Vertex en angle aigu à bords droits, assez long (environ les deux tiers de la largeur entre les yeux), une fine carène sur la partie frontale du vertex, côtés latéro-antérieurs du pronotum assez courts; élytres à extrémité moins aigue que celle de la plupart des *Clovia* africains, trois fois plus longs que larges; sur le milieu du front un sillon peu profond; rostre court s'étendant jusqu'aux hanches médianes; deux épines sur les tibias postérieurs; ocelles à égale distance l'un de l'autre et des yeux.

Longueur, ♂ 7 mm., ♀ 8 mm.

Habitat: South Africa, Cape Province, Worcester, 27–30.iii.1921 (*R. E. Turner*).

11. **Clovia parvula,** sp. nov.

Gris-jaune-paille, ou gris-brun; la partie externe de l'élytre, en dehors du radius est blanchâtre; nervures et point compris entre la branche interne du radius et le médian, bruns, ou noirâtres; partant de l'angle apical, une ligne d'un brun plus ou moins foncé, s'étendant jusqu'au point brun, et pouvant même le dépasser légèrement; sternum à milieu brunâtre; toute la surface supérieure recouverte d'une villosité argentée. Vertex en angle à peu près droit, sa longueur n'égale pas la moitié du bord postérieur, une fine carène sur la partie frontale du vertex; pronotum sexangulaire à bords latéro-antérieurs assez courts, et bord postérieur en angle très obtus; élytres à extrémité arrondie assez élargis vers la fin de tiers antérieur; deux épines sur les tibias postérieurs.

Longueur, 5 à 5·5 mm.

Habitat: South Africa; Cape Province, Mossel Bay, February 1922; Cérès, November 1920 and March 1921 (*R. E. Turner*).

12. **Clovia stevensi,** sp. nov.

Vertex, pronotum, écusson, ocre légèrement brun; sur le vertex quatre lignes longitudinales brun-noirâtre, les deux médianes sont plus larges et mieux marquées, et sept sur le pronotum; élytres brun-foncé, sur ceux-ci trois bandes, une première jaune-orange, à peu près droite part de la base de l'écusson pour arriver un peu en avant du milieu du bord externe, de chaque côté, elle est bordée de noir, plus en arrière, la deuxième jaune-orange sale part du bord externe (d'un point parallèle à l'extrémité de la nervure anale externe) et s'étend jusqu'à l'angle apical, enfin tout près du bord apical, la troisième jaune, disposée en angle obtus; dans la partie brune comprise entre les deux premières lignes

jaune-orange se trouvent des traits jaune-brun plus ou moins marqués; à l'extrémité du clavus un gros point noir, brillant; ailes légèrement enfumées, à nervures noires; front brun très clair, plus foncé sur le milieu; clypeus, rostre bruns; prosternum jaune légèrement brun; méso- et métasternum, abdomen, pattes, jaunes; le long du bord externe des cuisses médianes et postérieures une ligne brune; une grande tache noire, brillante, sur le mésosternum au devant des hanches médianes; tarière, extrémité des épines et griffes noires. Vertex plat, assez long, en angle aigu, à pointe arrondie; élytres longs et assez étroits, environ trois fois aussi longs que larges, à angle apical aigu; front transversalement strié; deux fortes épines sur les tibias postérieurs.

Longueur, 8·5 mm.

Habitat : N. India, Gopaldhara, Darjeeling, 4,720 ft.; 11.viii.1916 et 8.vii.1926 (*H. Stevens*).

13. **Clovia chinai,** sp. nov.

Vertex, pronotum, écusson, ocre-jaune; bords du vertex, trois bandes transversales sur celui-ci, et quatre sur le pronotum (bords antérieur et postérieur et deux médianes), bords latéraux de l'écusson, noirs; sur les élytres le noir domine: sur le clavus, deux larges lignes longitudinales ocre-brun clair, dont l'externe franchit la suture pour se continuer un peu sur le corium; à la partie apicale en partant du bord interne, cinq taches jaune-rouge, d'abord une tache en demi-rond en dedans du cubitus, puis une bande courte comprise entre le cubitus et le médian, ensuite trois taches longitudinales situées l'une derrière l'autre, et comprises entre le médian et le radius; le long du bord externe trois taches jaunes, la première étroite, un peu en avant du milieu, les deux autres à la partie apicale et l'une près de l'autre, la deuxième est disposée en triangle allongé, la troisième s'étend jusqu'à l'angle apical; front, rostre, sternum, jaunes, sur la partie supérieure du front, quatre lignes transversales noires se réunissant le long du bord externe pour former une large bande noire, s'étendant jusqu'au commencement du mésosternum; extrémité du rostre brune; segments abdominaux ocre-jaune, bordés de noir en arrière; tarière noire; pattes antérieures et médianes brun-noir; base des cuisses et tibias médians, ocre-jaune, à l'extrémité, bruns; tibias et tarses jaune-brunâtre; extrémité des épines et des tarses brun-noirâtre. Espèce voisine de *C. lineolata,* Lallemand, s'en distingue par le vertex plus étroit, plus en angle aigu (à pointe arrondie) et par le dessin et la forme des élytres, dont la partie apicale est moins anguleuse et plus arrondie; rostre s'étendant jusqu'à la base des hanches médianes; deux épines sur les tibias postérieurs.

Longueur, 7·5 mm.

Habitat : Philippine Is., Luzon, Baguio, 26.ii.1920 (*Dr. A. Moore*).
Je dédie cette espèce au très aimable Mr. W. E. China du British Museum.

14. **Clovia regalis,** sp. nov.

Partie frontale du vertex brun, à la pointe une petite tache jaune-brun, à son bord postérieur une ligne brun-foncé; vertex brun-clair, près du bord postérieur une bande brun-foncé suivie d'une fine ligne jaune-brunâtre; pronotum, brun-clair dans la partie antérieure, jaune-brunâtre dans la postérieure, la partie brune est traversée par une fine bande jaunâtre; écusson jaunâtre à extrémité brune; élytres brun-foncé, un peu plus clairs vers la base et l'extrémité, parsemés de points noirs et recouverts d'une villosité dense, blanc-gris, sur ceux-ci, trois taches jaunâtres, deux sur le clavus, une assez près de sa base, et une seconde non loin de sa pointe, la troisième sur le corium, transversale, située près du bord externe, légèrement en avant du niveau de la deuxième; front, second article du rostre, prosternum, côtés du mésosternum, abdomen, noirs; pattes brunes; milieu du mésosternum et métasternum ocre.

Vertex en angle aigu, à extrémité arrondie; ocelles un peu plus près l'un de l'autre que des yeux; bord postérieur du pronotum en angle obtus; écusson plus long que large; stries du front peu marquées; rostre s'étendant entre les cuisses médianes.

Longueur, 5·5 mm.

Habitat : Queensland, Kuranda, May 1904 (*T. P. Dodd*).

15. **Cordia rotundiceps,** sp. nov.

Ressemble à *C. albilatera* par la coloration générale gris-jaune-paille, partie de l'élytre externe au radius blanc-jaunâtre; nervures légèrement brunes; cellule basale et radius plus foncés, un point brun entre le médian et la branche externe du radius; s'en distingue par le vertex en forme de lunule, à bord antérieur arrondi et dont la longueur égale à peu près le tiers de son bord postérieur.

♂ gonapophyses à extrémité renflée en forme d'olive et noire.

Longueur, 5 mm.

Habitat : South Africa, Pondoland, Port St. John, April 1923 (*R. E. Turner*).

16. **Microsargane ornatipennis,** sp. nov.

♂. Front ocre-jaune à stries noires, son extrémité et le clypeus, noirs; vertex, pronotum, écusson, brun plus ou moins foncé; une bande blanc-jaunâtre de chaque côté du vertex, du pronotum et se continuant sur à peu près la moitié antérieure du clavus le long de la suture; élytres bruns, plus foncés à la partie apicale, ayant une bande longitudinale sur le clavus et une seconde sur le corium, blanc-jaunâtre. Cette dernière est un peu oblique en arrière et en dedans, elle part du bord externe au commencement du tiers apical et s'étend jusqu'à la branche interne du clavus, à cet endroit elle est continuée par une bande rouge transversale s'étendant jusque près de l'extrémité du clavus qui est blanchâtre; la bande blanche est bordée en arrière par une ligne brune partant du bord externe, derrière celle-ci se trouve un espace triangulaire hyalin; sur la partie apicale brun-noir en arrière des bandes blanche et rouge se trouvent deux taches blanches allongées, un peu obliques vers le bord interne, en arrière de cette partie brun-noir se voit une bande transversale ocre et enfin l'extrémité est brun-foncé; ailes enfumées à nervures noires; pattes, sternum, ocre; partie du mésosternum au devant des hanches médianes, brune; segments abdominaux bruns, bordés d'ocre-jaune en arrière.

Un léger sillon sur le milieu du front, vertex un peu moins long que large à son bord postérieur; partie frontale du vertex ayant une fine carène, son bord antérieur est en angle obtus; un fin sillon sur le milieu du pronotum; élytres longs et étroits; deux épines sur les tibias postérieurs.

Longueur totale, 8 mm.; élytres : longueur, 6 mm., largeur, 2 mm.

Habitat : Ecuador, Paramba, 3,500 ft., February 1897, dry season (*Rosenberg*).

17. **Microsargane procera,** sp. nov.

♀. Voisin du précédent, peut-être en est-ce la femelle? Élytres brun-clair, une bande le long du bord externe et la partie apicale brun-foncé, une tache rouge au devant de cette dernière, sur celle-ci, deux taches blanches allongées, une près du bord externe, transversale et une seconde oblique entre le médian et le cubitus au devant du bord apical, enfin à peu près parallèle à lui une bande jaune; vertex, pronotum, écusson, sternum, face inférieure de l'abdomen, bruns; front ocre-brunâtre, à stries transversales noires, sa partie inférieure et le clypeus sont d'un brun plus ou moins foncé; face supérieure de l'abdomen brun-rougeâtre brillant à reflets violets; ailes enfumées à nervures noires;

mésosternum plus foncé au devant des hanches médianes; métasternum et pattes, ocre plus ou moins brun; pronotum et élytres recouverts d'une villosité dense.

Vertex plan en angle obtus, un peu moins long que large au bord postérieur, ocelles assez petits, très légèrement plus près l'un de l'autre que des yeux, une fine carène sur la partie frontale du vertex; pronotum finement strié en travers, sans carène, à bord antérieur peu convexe, presque droit, à bord postérieur peu concave; écusson grand, à large fossette centrale, peu profonde; élytres longs, et étroits, médian et cubitus soudés sur la partie basale du corium; front bombé ayant un faible sillon médian; rostre s'étendant jusqu'aux hanches médianes; deux épines sur les tibias postérieurs.

Longueur totale, 9·5 mm.; élytres: longueur, 8 mm., largeur, 3 mm.

Habitat: Ecuador, Cachabé, XI–XII.1896 (*Rosenberg*).

18. **Ptyelus speciosus,** sp. nov.

♀. Vertex brun-clair; pronotum et écusson ocre légèrement brun; front jaunâtre, sur le milieu une grande tache triangulaire brune; élytres bruns, plus foncés par places, surtout en bordure de bande et tache, vers le milieu, partant du bord externe, une bande blanche qui se dirige, en se retrécissant, vers le bord interne, immédiatement après la pointe de l'écusson, à la partie apicale, le long du bord externe, une grande tache hyaline, dans laquelle se trouvent deux nervures transversales, et une longitudinale plus au moins brunes; sternum, cuisses, abdomen ocre-jaune; sur les cuisses postérieures, une ligne brune longitudinale; premier article du rostre brun, le second, l'extrémité des tarses et des épines ainsi que la tarière, noirs.

Vertex plan, en angle obtus, à côtés convexes, partagé en trois parties égales par deux sillons bien marqués, continuant ceux délimitant la partie frontale du vertex, sur cette dernière une fine carène longitudinale; ocelles un peu plus près l'un de l'autre que des yeux; pronotum ponctué en stries transversales, parallèlement au bord antérieur, et non loin de ce dernier une dépression transversale; élytres assez brillants, à nervures saillantes, et à cellules assez concaves; sur à peu près toute la moitié antérieure, médian et cubitus soudés, radius se bifurquant à la partie apicale; deux épines sur les tibias postérieurs; rostre s'étendant jusqu'à la base des hanches médianes.

Longueur, 6 mm.

Habitat: South Africa, Cape Province, George, 19–21.i.1922 (*R. E. Turner*).

19. **Ptyelus transfasciatus,** sp. nov.

♂. Vertex ocre, bord antérieur (s'épaississant au milieu), et une ligne transversale, réunissant les yeux, brun-noir; moitié antérieure du pronotum ocre-jaune; derrière le bord antérieur, une ligne transversale noire, s'étendant d'un œil à l'autre, partie postérieure brune, un peu plus claire juste en avant du bord postérieur; écusson jaune-brun à fossette centrale brune; élytres présentant le même dessin que ceux de l'espèce précédente, mais la bande d'un blanc légèrement jaunâtre est plus large et mieux marquée; face inférieure de la tête ocre-jaune, traversée par une bande noire partant de l'angle externe de l'œil et s'étendant sur celui-ci; les joues, le front et scrobes brun-noir; sternum à milieu noir et à côtés jaunes; abdomen brun-noir; pattes jaunâtres.

Longueur, 5 mm.

Habitat: South Africa, Pondoland, Port St. John, 1–9.vii.1923 (*R. E. Turner*).

Voisin de *P. speciosus* par le dessin des élytres et les caractères anatomiques, peut-être est-ce le mâle de cette espèce, qui présenterait, comme beaucoup d'autres Cercopides, du dimorphisme sexuel, mais comme ils ne proviennent

pas de la même contrée et ont été pris à des dates différents, je n'ai pas osé les réunir et en faire une seule espèce.

Sous-famille CERCOPINAE.

20. **Gynopygoplax atkinsoni,** sp. nov.

Tête, pronotum, ocre-rouge; écusson brun-noir; sur les élytres noirs, base et deux bandes transversales, rouges (sur l'exemplaire servant de type, la bande antérieure est évanescente, et la postérieure est moins fortement marquée à la partie médiane); ailes brunes à nervures noires et à base rouge; face supérieure de l'abdomen noir-bleuté; sternum, face inférieure de l'abdomen, rostre, pattes, noirs; bords latéraux du prosternum ocre-rouge.

Pronotum densèment ponctué, à fine carène médiane; écusson transversalement strié, à grande fossette centrale; médian et cubitus non soudés sur le tiers antérieur des élytres; sur les ailes, le radius I est réunie à la branche externe de bifurcation du radius II; protubérances mésosternales coniques, légèrement dirigées en avant, rostre n'atteignant pas les hanches médianes.

Longueur totale, 21·5 mm.; longueur du corps, 16·5 mm.; élytres: longueur, 14 mm., largeur, 5 mm., étendus, 44 mm.

Habitat : India? (*Atkinson Collection*).

21. **Gynopygoplax mounseyi,** sp. nov.

Front brun-noirâtre; vertex brun-clair; pronotum gris-brun clair; sur les élytres noirs, trois taches ocre-brun, la première occupe la plus grande partie du clavus, à l'exception d'un bord externe et d'un interne, la deuxième de même longueur que la première occupe la région du cubitus, la troisième se trouve sur le quart basal entre le radius et le bord externe, extrémité et quart postérieur du bord externe bruns, transparents; ailes brun-noir, à base ocre-brun; second article du rostre, sternum, écusson, cuisses, face inférieure de l'abdomen, noirs; premier article du rostre, tibias et tarses, brun-foncé; face supérieure de l'abdomen et organes génitaux, bruns. Sur le milieu du front, une bande lisse et sur les côtés, des sillons transversaux bien marqués; pronotum plus large que long, à surface fortement ponctuée, à carène longitudinale n'atteignant pas le bord postérieur, angles latéraux assez saillants arrondis à l'extrémité; écusson transversalement strié, ayant une grande fossette centrale sur le corium, médian et cubitus non soudés, réunis par un rameau transverse; protubérances du mésosternum coniques, légèrement dirigées en avant; deux épines sur les tibias postérieurs.

Longueur totale, 27 mm.; longueur du corps, 22 mm.; élytres: longueur, 21 mm., largeur, 7 mm., étendus, 52 mm.

Habitat : Philippine Islands (*J. J. Mounsey*).

22. **Suracarta tricolor,** Lep. et Serv.

Subspecies *impunctata*, nov.

Élytres sans aucune tache; pronotum ocre-jaune légèrement brunâtre, plus foncé au niveau des fossettes situées en arrière du bord antérieur.

Habitat : Mt. Matang, W. Sarawak, 21.xii.1913 (*G. E. Bryant*).

23. **Ectemnonotum amplum,** sp. nov.

♀. Entièrement noir, sauf l'extrémité des élytres brun-noirâtre. Sur le front une carène médiane et de fortes stries transversales; pronotum densèment ponctué en stries trans-

versales, légèrement rugueux, à carène médiane marquée seulement dans la moitié antérieure; écusson fortement strié en travers, à fossette centrale large, mais peu profonde; rostre court, n'atteignant pas le bord postérieur des protubérances du mésosternum; deux fortes épines sur les tibias postérieurs. Ressemble à *E. atrum*, Lallemand, s'en distingue par les stries et carène du front, la ponctuation du pronotum (qui est lisse et brillant chez *E. atrum*), et par l'écusson beaucoup plus fortement strié et à fossette moins profonde.

Longueur totale, 23 mm.

Habitat : Borneo (*Fry Collection*).

24. **Ectemnonotum dissolutum,** sp. nov.

♀. Tête, pronotum, écusson, élytres, bruns; yeux gris-brun tachés de noir; extrémité des élytres plus foncée, spécialement à la partie externe, sur ceux-ci deux bandes transversales composées de taches jaune-pâle, la première bande située près de la base a cinq taches, trois sur le corium et deux sur le clavus (la tache médiane du corium est légèrement en arrière des deux autres), la seconde bande en a cinq également, dont la première, au bord externe, est transversale et allongée, les quatrième et cinquième peuvent se souder; ailes enfumées, à nervures brunes; face supérieure de l'abdomen, bleue, brillante, à base et extrémité brunes; métasternum ocre-brun; face inférieure brune.

Pronotum fortement ponctué, ridé en travers, à carène longitudinale surtout marquée à la partie antérieure; écusson transversalement strié, plus long que large; rostre s'étendant entre les hanches médianes; sur les élytres, médian et cubitus non soudés, réunis par un rameau anastomotique; protubérances du mésosternum aplaties, transversales, bord postérieur ayant une petite dent à chaque angle.

Longueur totale, 13·5 mm.; longueur du corps, 9 mm.; élytres: longueur, 9 mm., largeur, 3·5 mm., étendus, 27 mm.

Habitat : Java (*Horsfield*).

25. **Megastethodon maritimus,** sp. nov.

Tête noire, légèrement rougeâtre; yeux ocre-brun; ocelles jaunes; pronotum rouge avec une tache brun-rouge entre les fossettes et le bord antérieur, ou brun-rouge foncé avec une tache rouge de chaque côté, en arrière des yeux, au niveau du milieu du bord antéro-externe, écusson brun-rouge clair ou noir-rougeâtre; abdomen noir bleuté; sternum, cuisses, médianes et postérieures, extrémité des épines, noirs; rostre, pattes rouges; ailes brunes, à base rosée et nervures noires; à peu près les neuf-quinzièmes antérieurs des élytres rouges, partie apicale noire, cette couleur se prolonge en avant en une fine bande le long du bord externe jusqu'à l'extrémité du premier tiers, sur la partie rouge se trouve une tache brun-noir ou noire plus ou moins en forme de ⌋ dont la pointe touche le bord externe et la branche transversale s'étend jusqu'au cubitus, parfois sur le clavus, en prolongement de cette branche et entre la nervure anale et le bord interne une seconde tache de même couleur, mais beaucoup plus petite.

Pronotum densèment ponctué, légèrement rugueux, ayant une carène longitudinale, surtout saillante en avant; écusson transversalement strié, ayant trois fossettes, une grande, centrale et deux petites, antérieures; médian et cubitus réunis sur une certaine distance sur le tiers antérieur du corium; sur les ailes le radius I est réuni tantôt au radius II en avant de sa bifurcation, tantôt au niveau de celle-ci, ou même à la branche externe immédiatement après la bifurcation; protubérances du mésosternum coniques; rostre s'étendant entre les hanches médianes.

Longueur totale, 19 mm.; longueur du corps, 15 mm.; élytres: longueur, 15 mm., largeur, 6 mm., étendus, 38 mm.

Habitat : Malay Archipelago, Humboldt Bay (*W. Doherty*).

26. **Megastethodon carbonarius,** sp. nov.

♀. D'un noir anthracite, brillant, spécialement sur les élytres; ocelles jaunes; yeux gris-rouge; métasternum, une fine bordure des segments abdominaux, dernier segment, organes génitaux, et pattes, d'un rouge plus ou moins brun; ailes noires à base rouge. Ocelles gros, pronotum rugueux fortement et densèment ponctué en stries plus ou moins transversales, à fine carène médiane, n'atteignant pas les bords antérieur et postérieur; écusson transversalement strié, à grande fossette centrale; médian et cubitus réunis sur une certaine distance sur le tiers basal du corium; rostre s'étendant entre les hanches médianes; protubérances mésosternales coniques légèrement dirigées en avant; deux épines sur les tibias postérieurs, une très forte et une petite.

Longueur totale, 19 mm.; longueur du corps, 15 mm.; élytres: longueur, 16 mm., largeur, 5·5 mm.

Habitat : Dutch New Guinea, Angi Lake.

27. **Cosmoscarta egentior,** sp. nov.

Tête noire; yeux gris-brun; ocelles jaunâtres; pronotum ocre-brun ou brun-clair, bords latéraux et postérieur ainsi que les fossettes situées derrière le bord antérieur, noirs; la carène médiane peut être noir-brun sur certains exemplaires; écusson rouge légèrement teinté de brun vers l'extrémité; élytres bruns, plus foncés à l'extrémité et vers le bord externe, base du clavus et une ligne longitudinale à la base du corium, rouges; partie apicale réticulée séparée de la partie antérieure par une ligne plus claire, bord interne jusqu'au niveau de la pointe de l'écusson noir-brun; ailes brunes, à nervures noires, et à base rouge; abdomen noir légèrement violacé, les deux premiers segments finement bordés de rouge en arrière et sur les côtés; organes génitaux, sternum, rouges; protubérances brunes; rostre rouge, sauf l'extrémité brun-rougeâtre; pattes brun-rougeâtre; hanches et partie basale des cuisses rouges.

Pronotum densèment ponctué, brillant, à carène médiane; sur les élytres, médian et cubitus, non soudés, réunis par un rameau anastomotique; sur les ailes, radius I réuni à radius II par un rameau transverse, avant sa bifurcation; protubérances légèrement dirigées en avant; deux épines sur les tibias postérieurs.

Longueur totale, 22·5 mm.; longueur du corps, 16 mm.; élytres: longueur, 17 mm. largeur, 6 mm., étendus, 42 mm.

Habitat : Raiot Dong, Sikkim, 28.vi.1903 (*Expedition to Tibet*).
Cette espèce fait partie du groupe *C. egens*.

28. **Cosmoscarta luangana,** sp. nov.

Tête noire, brillante; yeux ocre-gris tachés de noir; pronotum noir à reflets métalliques bleu-verdâtre; écusson noir à extrémité brune; élytres noirs, devenant légèrement transparents à l'extrémité; base du clavus ainsi qu'une tache (moins nette) près de l'extrémité de celui-ci, ocre-brun, une tache au devant de la partie reticulée entre la branche externe du radius et le bord externe (mais ne touchant pas celui-ci) ocre-jaune pâle; ailes brunes à nervures noires; prosternum noir; mésosternum et métasternum noirs, bruns par places, spécialement à l'extrémité des protubérances; pattes brunes plus foncées par places; abdomen noir, bords postérieur et latéraux des segments étroitement brun-clair.

Pronotum finement et densèment ponctué, brillant, à fine carène médiane et à bord postérieur droit; ocelles petits, légèrement plus près des yeux que l'un de l'autre; rostre s'étendant jusqu'entre les hanches médianes; protubérances du mésosternum bien saillantes, légèrement transversales.

Longueur totale, 17 mm.; longueur des élytres, 14 mm.

Habitat : Laos, Luang Prabang, Hat Tiang, 14.xii.1917 (*R. V. de Salvaza*).

29. **Cosmoscarta bruneoscutellata,** sp. nov.

Tête brun-foncé; écusson noir; face supérieure de l'abdomen noir-brun, face inférieure noir-bleuté; pattes, sternum, organes génitaux, bruns; yeux gris, avec une grande tache noire; tête, pronotum, élytres ocre; les élytres vers l'extrémité prennent une teinte légèrement rougeâtre et deviennent plus ou moins transparents, sur ceux-ci, sept taches noires disposées en deux bandes, trois sur la première (sur le type l'externe est peu marquée) et quatre sur la seconde, dans les grandes cellules, en bordure de la partie réticulée, des taches brunes.

Ocelles un peu plus près l'un de l'autre que des yeux; pronotum très densèment et finement ponctué, à carène médiane mousse, peu saillante; sur le corium, médian et cubitus réunis par un rameau transverse; mésosternum au devant des protubérances en forme de bourrelet transversal; deux épines sur les tibias postérieurs, une petite et une très forte.

Longueur totale, 11·5 mm.

Habitat : Tonkin, June 1917 (*R. V. de Salvaza*).

30. **Cosmoscarta contigua,** sp. nov.

♀. Tête noir-bleu; yeux gris-brun, tachés de brun foncé; pronotum bleu-verdâtre, brillant, écusson noir; élytres noirs, brillants, ayant deux bandes disposées comme celles de *C. fruhstorferi*, Jac., la première partant de l'extrémité de l'écusson et la seconde de la pointe du clavus; premier article du rostre, hanches, cuisses, métasternum, bords latéraux et postérieur des segments abdominaux, organes génitaux, base des ailes, rouge-carmin; organes génitaux et milieu des cuisses teintés de brun; pro- et mésosternum, abdomen, noirs, brillants.

Tête renflée à milieu lisse, sur les côtés des stries transversales, bien marquées; ocelles petits à égale distance l'un de l'autre et des yeux; pronotum densèment ponctué, à faible carène médiane, à angle huméraux arrondis, à bord postérieur légèrement concave; écusson plus long que large; sur le corium, médian et cubitus non soudés, réunis par un rameau transverse; rostre s'étendant jusqu'à la base des hanches médianes; protubérances transversales aplaties d'avant en arrière; une seule épine sur les tibias postérieurs.

Voisin de *C. fruhstorferi*, s'en distingue au point de vue anatomique, par la forme des protubérances et par les tibias postérieurs n'ayant qu'une épine.

Longueur totale, 12 mm.

Habitat : Indo-China (*R. V. de Salvaza*).

31. **Leptataspis patagiata,** sp. nov.

D'un rouge plus ou moins brunâtre; abdomen bleu-noirâtre à la face supérieure et noire à l'inférieure; ailes enfumées, brunes, à base rouge et nervures noires. Élytres rouge-carmin, partie apicale, bord externe en arrière du tiers antérieur, largement, bord interne jusqu'à l'écusson, étroitement, noirs; sur la partie rouge deux taches brun-noir, assez grandes, plus ou moins triangulaires, la première partant de la base, est comprise entre le radius et la suture; la seconde, un peu en arrière de la séparation du médian et du cubitus, longe la suture.

Pronotum légèrement rugueux, ponctué en lignes transversales, à carène peu nette, indiquée surtout en avant; ocelles jaunes, situés à égale distance l'un de l'autre et des yeux. Bord postérieur du mésosternum quelque peu saillant; protubérances obtuses; une épine sur les tibias postérieurs.

Longueur totale, 17 mm.; longueur des élytres, 13·5 mm.; élytres étendus, 33 mm.

Habitat : Malay Archipelago, Sumbawa (*W. Doherty*).

32. **Leptataspis bansaina,** sp. nov.

Tête noire, yeux bruns, ocelles jaunes; pronotum brillant, noir-bleuâtre; écusson brun-rouge; élytres rouge-brique un peu foncé, partie réticulée et une tache au bord externe, noires; ailes enfumées; pro- et mésosternum noirs, protubérances brunes; métasternum brun; pattes et abdomen, brun légèrement rougeâtre.

Pronotum densèment et finement ponctué en stries plus ou moins transversales, sur son milieu, une fine carène n'atteignant pas les bords antérieur et postérieur; sur le tiers antérieur des élytres, le médian et le cubitus sont réunis sur une courte longueur. Protubérances du mésosternum aplaties transversalement. Ocelles situés à distance à peu près égale l'un de l'autre et des yeux.

Longueur totale, 16 mm.; longueur des élytres, 11 mm.; largeur des élytres, 4 mm.

Habitat : Xieng Khouang, Ban-sai, 26.x.1917 (*R. V. de Salvaza*).

33. **Leptaspis insularis,** sp. nov.

Tête, pronotum, brun-noirâtre; yeux, gris-brun, tachetés de noir; écusson, élytres, noirs; moitié basale du clavus et quart basal du corium dans la partie externe au radius, d'un jaune variant du grisâtre au rougeâtre; sur la partie jaune du corium, une tache noire arrondie située près du bord externe tantôt restant indépendante de celui-ci, tantôt se réunissant à lui, de même sur la partie colorée du clavus une tache noire plus ou moins grande, le long de la suture, ce qui donne comme dessin général, une base jaune avec un triangle médian et deux taches latérales, noirs; ailes enfumées, à nervures noires, base et environ les deux tiers antérieurs du bord externe ocre; pro- et mésosternum, noirs; métasternum blanc-gris à taches noires; abdomen à segments noirs finement bordés de gris-jaunâtre; pattes ocre-brun clair; cuisses médianes longitudinalement de deux couleurs ocre-brun clair et noir-brun, cuisses postérieures noir-brun. Face supérieure de l'insecte brillante; ocelles gros, à égale distance l'un de l'autre et des yeux; pronotum légèrement ponctué, à carène médiane seulement bien indiquée sur le milieu; médian et cubitus réunis sur le tiers basal du corium; protubérances du mésosternum transversales et bien saillantes.

Longueur totale, 20 mm.; élytres : longueur, 17 mm., largeur, 6 mm., étendus, 42 mm.

Habitat : Philippine Is. (*J. Mounsey*).

34. **Leptataspis trifasciata,** sp. nov.

Répond fort exactement à la description de *Cosmoscarta trifasciata*, Schmidt, s'en distingue par : 1°) la réunion du médian et du cubitus sur une certaine longueur à la base du corium; 2°) une seule épine sur les tibias postérieurs; 3°) un fin prolongement de la première bande qui suit le bord interne et va se réunir à la deuxième; 4°) élytres noirs au lieu de brun-noir; rostre et tarses brun-noir.

Sur le pronotum une trace de carène marquée surtout à la partie médiane. S'il n'existait qu'un seul caractère anatomique différentiel c. à d. la soudure du médian et du cubitus, on pourrait se demander si ce caractère, pris par Schmidt comme une des bases principales de sa subdivision de l'ancien genre *Cosmoscarta*, est vraiment fixe, mais une seconde particularité heureusement se présente, le nombre d'épines des tibias postérieurs.

Longueur totale, 12 mm.; longueur du corps, 8 mm.

Habitat : Tonkin; Chapa, June 1916 (*R. V. de Salvaza*).

35. **Leptataspis specialis,** sp. nov.

♀. Tête, sternum (sauf les côtés du prosternum), abdomen, une tache sur le pronotum en arrière du bord antérieur et de la largeur de la tête, une large bande médiane trans-

versale sur les élytres, extrémité des épines et des tarses, noirs ; pronotum, écusson, élytres (en partie), pattes, ocre-jaune ; les élytres présentent le dessin suivant : base ocre-jaune, une large bande noire plus large au bord interne, une bande ocre-jaune assez étroite s'élargissant vers le bord externe et enfin une partie apicale et réticulée brun-clair ; ailes enfumées, à nervures brunes, à base ocre-jaune ; yeux gris ; ocelles jaunâtres ; bords postérieurs des segments abdominaux et organes génitaux, jaunes. Ocelles petits, à peu près à égale distance l'un de l'autre et des yeux ; pronotum densèment ponctué, sans carène longitudinale, à bords latéro-antérieurs, lamellaires, légèrement relevés, parallèlement à ceux-ci et près d'eux court un sillon ; médian et cubitus réunis sur un trajet assez court ; mésosternum sans protubérance, en bourrelet transversal ; deux épines sur les tibias postérieurs, une petite près de la base, et une forte au commencement du tiers postérieur.

Longueur totale, 13 mm. ; élytres : longueur, 10 mm., largeur, 3·5 mm.

Habitat : North India, Sikkim, Gopaldhara, 1916 (*H. Stevens*).

36. **Trichoscarta curvata,** sp. nov.

♀. Tête, pronotum, prosternum, écusson, vert-foncé, brillants, sur la partie antérieure du front, une tache allongée, orange ; ocelles jaunes ; élytres bruns, sur ceux-ci deux bandes transversales et une longitudinale orange, la longitudinale suit le bord interne jusqu'environ le milieu de l'écusson, la première transversale fortement incurvée, part du bord interne au niveau de la pointe de l'écusson en direction oblique en arrière et en dehors, à la sortie du clavus, devient à peu près transversale (très légèrement dirigée en avant) jusqu'au radius, puis redevient oblique, mais en avant et en dehors pour arriver au bord externe au même niveau qu'à l'interne, sur le radius et le cubitus elle donne des petits prolongements en arrière ; la seconde bande est transversale, située au devant de la partie apicale réticulée ; ailes brunes, à nervures noire, et à base rosée ; méso- et métasternum ocre-brun ; face inférieure de l'abdomen noires face supérieure bleu-violet, brillante ; tarière brun-foncé ; hanches et cuisses brun-clair ; rostre, tibias et tarses ocre-brun ; extrémité du rostre et des épines brun-noir ; surface supérieure de l'insecte recouverte d'une villosité rousse.

Ocelles situés un peu plus près l'un de l'autre que des yeux ; milieu du front lisse, sur les côtés, des sillons transversaux ; pronotum très finement ponctué, à carène médiane n'atteignant pas le bord postérieur, surtout marquée dans la moitié antérieure ; deux épines sur les tibias postérieurs. Médian et cubitus réunis sur une certaine distance sur le tiers basal du corium ; protubérances du mésosternum transversales, à bord postérieur relevé.

Longueur totale, 15 mm.

Habitat : Sarawak, May 1892.

37. **Phymatostetha testacea,** sp. nov.

Tête, bords latéraux du prosternum, pronotum, écusson, rouge-brique ; partie postérieure du vertex, fossettes du pronotum, noir-brun ; extrémité de l'écusson brunâtre ; élytres ayant une teinte un peu plus claire que le pronotum et l'écusson, à extrémité rouge-brun clair, montrant une tache et une bande brun-noir, la tache se trouve à la fin du quart basal entre le radius et le bord externe, la bande, convexe en arrière, commençant à l'extrémité du tiers médian du bord externe, longe celui-ci, puis le quitte pour rejoindre le bord interne ; ailes brunes, à base rouge et à nervures brunes ; rostre, sternum, pattes, abdomen, noirs ; face supérieure de l'insecte recouverte d'une villosité rousse.

Pronotum densèment ponctué en stries plus ou moins transversales, légèrement rugueux, ayant une fine carène qui n'atteint pas le bord postérieur ; écusson ayant une large fossette ; élytres trois fois plus longs que larges, sur le tiers basal, médian et cubitus réunis, réseau apical peu dense ; sur les ailes, radius I réuni à radius II avant sa bifurcation ; rostre

s'étendant entre les hanches médianes; protubérances du mésosternum transversales; deux fortes épines sur les tibias postérieurs.

Longueur totale, 25 mm.; longueur du corps, 20 mm.; élytres: longueur, 21 mm., largeur, 7 mm., étendus, 48 mm.

Habitat : Laos, Xieng Khouang, Ban sai, 26.ix.1917 (*R. V. de Salvaza*).

38. **Eoscarta borealis,** Distant.

Var. *tristis*, nov.

Tête, pronotum, sternum, premier article du rostre, ocre-brun; écusson fréquemment un peu plus foncé; second article du rostre, tibias antérieurs et médians, extrémité des tibias postérieurs, noirs; élytres rouge-foncé; ailes brun-foncé; l'insecte est recouvert d'une villosité très dense.

Habitat : Laos, Luang Prabang, September 1917 et August 1917 (*R. V. de Salvaza*).

Types : Collection du Musée de Londres et la mienne.

39. **Aufidus nilgiriensis,** sp. nov.

♀. Tête, pronotum, écusson, pro- et mésosternum, noirs; élytres hyalins, sauf la base, le bord externe jusqu'à l'extrémité, le bord interne jusqu'à la pointe du clavus, les nervures et la partie apicale du bord externe au médian, noirs ou brun-noir; devant la partie apicale brun-noir une tache ovale rouge-carmin; ailes enfumées, à nervures noires; métasternum et abdomen rouges; premier article du rostre jaune-brun, second article et pattes, bruns; extrémité des tibias et tarses brun-noir; cuisses postérieures teintées de rouge. Front à sillon médian, mais moins net que dans l'espèce suivante et à bords mousses; tibias postérieurs ayant une forte épine.

Longueur totale, 10 mm.; longueur du corps, 7 mm.

Habitat : India, Nilgiri Hills.

40. **Aufidus niger,** sp. nov.

♂. Tête, pronotum, prosternum, écusson et clavus, noirs, brillants; corium brun-noirâtre, ayant une grande tache d'un blanc-jaunâtre au bord externe, au devant de la partie apicale; méso- et métasternum, pattes, d'un brun très clair; tibias antérieurs, tarses et épines, brun-noirâtre; abdomen brun; sur la surface supérieure, un duvet rouge abondant, devenant jaunâtre sur la tache blanche.

Partie médiane du front creusée en un large sillon à fond uni, à bords carénés et commençant en dessous du bord antérieur.

Longueur, 10 mm.

Habitat : Indo-China; Haut Mékong, Nam Tiene, 14.iv.1918 (*R. V. de Salvaza*).

41. **Aufidus insularis,** sp. nov.

Tête jaune-pâle, une première bande à la base du vertex entre les yeux et une seconde, large, à la partie supérieure du front s'étendant légèrement sur la partie frontale du vertex, noires; yeux tachetés de noir; moitié antérieure du pronotum gris-jaunâtre, moitié postérieure noire; écusson jaunâtre, estompé de brun à la partie médiane et à bords brun-noirâtre; élytres gris-jaunâtre, à base légèrement brune le long des bords externe et interne, partie médiane comprise entre le cubitus et le radius presque hyaline, bord apical brun depuis les petites nervures transversales (externes au radius) jusque l'extrémité du

médian; ailes légèrement enfumées à nervures brunes; sternum, pattes, gris-jaunâtre; extrémité des tarses noirs (abdomen manque). Front à sillon large et profond, commençant presqu'au bord antérieur.

Longueur totale, 8·5 mm.

Habitat : Bali Is., Danau Bratan (*E. Streseman*).

42. **Mioscarta pallida,** sp. nov.

♂. Vertex et quart antérieur du pronotum, bruns, les trois quarts postérieurs de ce dernier blanc-jaunâtre; front, écusson, élytres, ailes, brun très clair; sternum, abdomen et pattes, d'un jaune très légèrement brun; extrémité des tarses et des épines brune; élytres transparents.

Sur la partie médiane du front un court sillon médian et de légères stries transversales; surface supérieure recouverte d'un duvet jaunâtre.

Longueur totale, 9·5 mm.

Habitat : Philippine Is. (*J. Mounsey*).

43. **Poeciloterpa fusca,** sp. nov.

Face supérieure noire ou brun-noir, légèrement rougeâtre; extrémité des élytres un peu plus claire; une bande rouge ou jaune-rougeâtre le long du bord externe s'élargissant en avant de la partie réticulée; ailes enfumées, à nervures noires; face inférieure du corps et abdomen bruns; yeux gris-brun, tachés de noir.

Partie médiane du front creusée en gouttière à bords en carène, parties latérales transversalement striées; une épine sur les tibias postérieurs.

Longueur, 6 mm.

Habitat : Philippine Is. (*J. Mounsey*).

44. **Abidama sexmaculata,** sp. nov.

Noire, sauf la moitié antérieure du bord externe des élytres brune, sur chacun de ces derniers, trois taches jaune-orange, une première sur le clavus plus ou moins triangulaire et contigue à celle de l'autre élytre, les deux autres sur le corium, une allongée longeant la suture, et dont l'angle antéro-externe est voisin du bord externe; et enfin la dernière ovale située au devant de la partie apicale, part du bord externe; ocelles jaunâtres, plus près l'un de l'autre que des yeux; yeux brun; métasternum brun-rougeâtre clair; abdomen brun-rougeâtre, à milieu plus foncé. Une épine sur les tibias postérieurs.

Longueur, 9·5 mm.

Habitat : Indo-China, Tonkin, Haut Mékong, Muong Sing, et Xieng Khouang, 6.vi.1919 (*R. V. de Salvaza*).

45. **Callitettix biformis,** sp. nov.

♂. Tête, pronotum, écusson, pro- et mésosternum, abdomen, pattes antérieures (sauf la base des cuisses, jaune), tibias médians (sauf leur base, jaune), cuisses et tarses postérieurs, noirs; yeux gris; bords antéro-externes du pronotum, bords latéraux de l'écusson, bords latéraux et postérieur du prosternum, cuisses médianes, tibias postérieurs (sauf leur extrémité, noire), jaunes; métasternum jaune-brunâtre; élytres hyalins dans les deux tiers antérieurs, à clavus légèrement enfumé, tiers postérieur, nervures, bord interne, noirs; au milieu de la partie apicale noire, une tache blanche, hyaline; ailes hyalines, légèrement enfumées, à nervures brun-noir; ocelles jaunâtres presque contigus, séparés par la carène longitudinale du vertex.

♀. Diffère du mâle par les couleurs plus nettes et les caractères suivants: yeux noirs; bord jaune du pronotum plus large; écusson jaune; élytres plus enfumés, plus noirs; clavus noir, sauf la bande longitudinale jaune de la base; sur le corium, trois taches blanches une première allongée triangulaire entre le radius et le bord externe, une deuxième près de l'extrémité du clavus et la troisième médiane, postérieure.

Longueur, 10·5 mm.

Habitat : Darjeeling, Gopaldhara, Rungbong Valley, vi.1920 (*H. Stevens*).

46. **Locris carbonarius,** sp. nov.

Noir, sauf une fine bande jaune-rougeâtre, le long des bords antéro-externes et antérieur du pronotum, des bords antérieur (sous les yeux) et latéraux du prosternum; métanotum et tibias, ocre-rouge; bords postérieur et latéraux des segments abdominaux, base des ailes rouges; bord apical des élytres brun-rougeâtre, leur bord interne est étroitement ocre jusqu'un peu plus loin que la pointe de l'écusson; à la base, entre le radius et le tronc commun du médian et du cubitus, une ligne brun-clair, élytres recouverts d'un duvet très épais, roux. Chez le ♂ la bande jaune qui longe le bord externe du prothorax (pronotum et prosternum) s'étend moins loin en arrière; les pattes et le bord apical des élytres sont moins rouges.

Front luisant, à carène médiane bien marquée, mais à stries transversales peu profondes; ocelles petits, beaucoup plus près l'un de l'autre que des yeux; pronotum rugueux, fortement ponctué, à carène médiane indiquée surtout à la partie médiane, mais peu saillante, de chaque côté de celle-ci de grandes fossettes; écusson ayant trois fossettes, deux petites antéro-latérales et une grande centrale; rostre court, atteignant à peine la base des hanches médianes; une seule épine sur les tibias postérieurs.

Longueur, 11·5 mm.

Habitat : Nyasaland, Mt. Mlanje, 26.xi.1912 et 13.xii.1913 (*S. A. Neave*).

47. **Triecphora kasengansis,** Lallemand.

Var. *trimaculata,* nov.

Diffère de l'espèce par le dessin des élytres; les trois-quarts antérieurs du clavus et deux taches sur le corium, jaunes; à la partie apicale la grande tache et devant celle-ci une plus petite.

Habitat : Nyasaland, Mt. Mlanje, 15.i.1913 (*S. A. Neave*).

CHINANA, gen. nov.

Se caractérise par la forme du front légèrement aplati, transversalement partagé en trois parties; une médiane lisse qui se creuse en gouttière vers l'angle inférieur et présente de chaque côté une petite saillie, et deux latérales, transversalement striées; vu de côté, il dessine un angle obtus à bord supérieur arrondi et inférieur droit; ocelles plus près l'un de l'autre que des yeux; sur les élytres, médian et cubitus se touchent en un point, puis se séparent immédiatement après; une épine sur les tibias postérieurs.

Type du genre : *C. argentina,* Lallemand.
Je dédie ce genre à Mr. W. E. China du British Museum.

48. **Chinana argentina,** sp. nov.

Tête, pronotum, écusson, à reflets verts; élytres brun-noir, à reflets légèrement violets, au devant de la partie réticulée une bande jaune, étroite au milieu et pouvant même

s'effacer à cet endroit, se renflant en taches à chacun des bords, mais l'externe est toujours beaucoup plus grande, bord interne du clavus finement brun-rougeâtre; ailes brunes, plus foncées vers l'extrémité; pro- et mésosternum, pattes, brun-noir; cuisses postérieures plus claires; métasternum ocre.

Longueur, 8 mm.

Habitat : Argentina, Province Salta, 20 et 22.i.1897 (*S. Venturi*).

49. **Sphenorhina phalerata,** Jacobi.

Var. *limbata*, nov.

Se différencie de l'espèce par le dessin de la première tache jaune des élytres : dans la varieté, celle-ci est séparée du bord externe par une bande de la couleur de l'élytre, et revêt la forme de la tache basale de *livida*, Jac., tandis que dans la forme typique elle s'étend jusqu'au bord; le rouge de la tête est légèrement plus brun.

Habitat : Argentina, Province Tucuman, 7.xi.1897 (*S. Venturi*).
Types : Collection du British Museum et la mienne.

50. **Sphenorhina simulans,** Walker.

Var. *unifasciata*, nov.

Se différencie de l'espèce en ce que les élytres ne portent qu'une seule bande jaune, mais fort large par suite de la disparition de l'espace brun séparant les deux bandes.

Habitat : Honduras.

51. **Sphenorhina monticola,** sp. nov.

♀. Ocre-brun clair, une bande située derrière le bord antérieur du pronotum ocre-jaune; sur les élytres, deux bandes transversales blanc-jaunâtre, la première partant de la pointe de l'écusson vers le bord externe, et la seconde située au devant de la partie réticulée, elle s'élargit en allant vers le bord externe; second article du rostre, tibias et tarses antérieurs, extrémité des autres tarses et des épines ainsi que la tarière, d'un brun plus ou moins foncé; ocelles brun-noirâtre.

Front transversalement aplati, carène médiane forte et stries transversales bien marquées, vu de côté, il montre un angle inférieur un peu plus grand qu'un droit; ocelles plus près l'un de l'autre que des yeux; vertex et pronotum brillants, sur le dernier, deux grandes fossettes en arrière des yeux; rostre dépassant légèrement les cuisses médianes; deux épines sur les tibias postérieurs, une petite et une très forte.

♂. Pronotum, tête, prosternum, cuisses antérieures et pattes médianes, ocre-rouge; bandes des élytres, ocre-jaune légèrement rougeâtre.

Longueur, 11 mm.

Habitat : Ecuador, Cachabé, xi–xii.1896 (*Rosenberg*).

52. **Sphenorhina biformis,** sp. nov.

♂. Tête brun-clair, sur le vertex, près des yeux, une tache noire; moitié antérieure du pronotum noire (sauf le long du bord externe), moitié postérieure et une petite bande le long du bord externe, écusson, élytres, ocre-brun clair; extrémité de l'écusson brun-noir; pro- et mésosternum, abdomen noirs; métasternum ocre-brun; pattes, organes génitaux, ocre; cuisses estompées de brun; épines et extrémité des tarses brun-noir; ailes enfumées, à nervures noires.

♀. Ocre-rouge, vertex un peu brun en dedans des yeux; pronotum brun-noir derrière

les yeux, puis rouge et enfin ocre-brun clair, bord externe rouge; extrémité de l'écusson brune.

Assez courte par rapport à sa largeur, globuleuse; front, vu de côté, présentant une pointe en angle aigu, carène médiane bien marquée; ocelles très proches l'un de l'autre, separés par la carène du vertex; pronotum sans carène; médian et cubitus réunis sur la base du corium; deux épines sur les tibias postérieurs.

Longueur totale, 8 mm.; élytres: longueur, 6 mm., largeur, 2·5 mm.

Habitat: Costa Rica, San José (*P. Biolley*).

53. **Sphenorhina brunnea,** sp. nov.

Front noir, brillant, vertex brun-foncé; pronotum brun plus foncé à la partie antérieure; écusson, élytres, brun-bronzé clair; face supérieure de l'insecte recouverte d'une villosité rousse, très dense; clypeus, premier article du rostre, pro- et mésosternum, brun-clair; pattes, métasternum, abdomen, brun-noir ou noir; second article du rostre noir; tibias postérieurs ayant une teinte rougeâtre.

Front quelque peu aplati transversalement, à carène et stries transversales fortes, vu de côté, il montre un angle légèrement obtus; forte carène sur le vertex et le pronotum, ce dernier à surface un peu rugueuse; sur la partie antérieure du corium, le médian et le cubitus se soudent; deux fortes épines sur les tibias postérieurs.

Longueur, 8 mm.

Habitat: Bolivia (*J. Steinbach*).

54. **Sphenorhina paraguayana,** sp. nov.

Front rouge-carmin, légèrement teinté de brun à la partie supérieure. Vertex, pronotum, écusson, noir-rougeâtre; la partie antérieure du pronotum est plus rouge; pointe de l'écusson rouge; élytres rouge-brique, sur ceux-ci deux taches brunes, toutes deux entre le radius et le médian, une immédiatement en arrière de la séparation du médian et du cubitus, et la seconde à la partie apicale; ailes enfumées à base rouge et nervures brunes; pro- et mésosternum, abdomen, noir-rougeâtre; métasternum rouge; pattes rouges, toutes les cuisses et les tibias postérieurs plus ou moins teintés de brun; une ligne au bord postérieur des segments abdominaux et une bande à leur bords externes rouge-carmin.

Front à carène saillante, et à stries transversales bien marquées, vu de côté, il montre un angle obtus, rostre s'étendant entre les hanches médianes; deux épines sur les tibias postérieurs; ocelles proches, séparés par la carène; pronotum rugueux, à fine carène sur la partie antérieure; médian et cubitus réunis vers la base du corium.

Longueur, 12·5 mm.

Habitat: Paraguay, Sapucay, 1905 (*W. Foster*).

55. **Monecphora brunneorubra,** sp. nov.

Tête, un peu moins de la moitié antérieure du pronotum, sternum, cuisses, abdomen, rouges; partie postérieure du pronotum noire; écusson, premier article du rostre, brun-rougeâtre; élytres bruns, transparents, à bord externe noir et extrémité brun-noir; le long du bord externe une bande longitudinale s'étendant jusqu'à la partie apicale ainsi que la base du clavus, rouge-grenat, se différenciant mal de l'ensemble quand on les regarde de dessus, mais tranchant fortement quand on les voit par transparence; second article du rostre, tibias antérieurs et médians, tarses, noirs; tibias postérieurs, organes génitaux rouge-brun.

Front à carène et stries nettes, un peu comprimé transversalement, vu de côté il est

arrondi, sans angle; ocelles plus près l'un de l'autre que des yeux; pronotum à surface densèment ponctuée, à fine carène médiane et à grandes fossettes de chaque côté de celle-ci; sur le corium, médian et cubitus réunis sur un court trajet; deux épines sur les tibias postérieurs.

Longueur, 10 mm.

Habitat : Brazil, Theresopolis, 12.ix.1887.

56. **Monecphora albo-ornata,** sp. nov.

Vertex, pronotum, écusson, noir-verdâtre; élytres noirs à base rouge-carmin, bord interne le long du pronotum, une tache ovoïde près du bord externe un peu en avant du milieu de la longueur et une bande au devant de la partie apicale, blancs; pronotum et élytres assez brillants; toute la surface supérieure recouverte d'une villosité dense; ailes enfumées, à base rouge et nervures noires; front, pro- et mésosternum, second article du rostre, pattes, noirs; premier article du rostre, base et extrémité des cuisses antérieures et médianes, rouge-carmin; hanches rouges tachées de brun; métasternum rouge-carmin; segments de l'abdomen noirs, finement bordés de rouge.

Front à carène et stries transversales très marquées, vu de côté, il est arrondi, sans angle, moyennement saillant; rostre s'étendant jusqu'aux hanches médianes; ocelles beaucoup plus près l'un de l'autre que des yeux, une fine carène sur le vertex; médian et cubitus non soudés sur le corium; pronotum ponctué irrégulièrement à carène médiane peu saillante; une grande fossette centrale, peu profonde, sur l'écusson; deux épines sur les tibias postérieurs.

Longueur, 8 mm.

Habitat : Paraguay, San Bernardino (*K. Fiebrig*).

57. **Monecphora birubromaculata,** sp. nov.

Tête, pronotum, prosternum, noirs à reflets bleu-verdâtre; écusson, élytres et abdomen, noirs; rostre, pattes, mésosternum, noir-rougeâtre; toutes les articulations fémoro-tibiales, une tache à la base des hanches, métasternum, une fine bordure des segments abdominaux, rouge-carmin; ocelles jaunes; face supérieure recouverte d'une villosité rousse, très dense; sur les élytres, au niveau de la pointe de l'écusson, deux taches rouges plus ou moins arrondies, une sur le clavus près de la suture et l'autre sur le corium entre la suture et le radius, sur certains exemplaires en dehors du radius une trace rouge.

Front, vu de côté, arrondi, à carène et stries transversales; ocelles beaucoup plus près l'un de l'autre que des yeux, séparés par une carène médiane; sur le pronotum une carène peu saillante; médian et cubitus réunis vers la base du corium; rostre s'étendant jusqu'aux cuisses médianes; deux épines sur les tibias postérieurs.

Longueur, 9·5 à 10·5 mm.

Habitat : Colombia, Buenaventura, Janvier 1878 (*Dr. Otto Thieme*).

TOMASPISINELLA, gen. nov.

Front lisse, bombé, sans carène médiane, à stries latérales à peine indiquées, présentant une partie médiane assez plane, et deux latérales; rostre long, s'étendant jusqu'à la base des hanches postérieures; vertex, à bord anterieur arrondi, à ocelles petits, proches l'un de l'autre, aussi long que la moitié de sa largeur au bord postérieur; pronotum fortement et densèment ponctué, à carène longitudinale; médian et cubitus réunis sur une certaine longueur vers la base du corium.

Type du genre : *T. parva*, Lallemand.

58. **Tomaspisinella parva.**

Tête, pronotum, écusson, noirs; élytres bruns, un peu plus foncés vers l'extérieur, sur ceux-ci, légèrement en arrière du milieu, trois taches blanches transversales formant une bande, une première entre le radius et le médian, une deuxième entre le médian et le cubitus, et la troisième entre le cubitus et la suture; ailes légèrement enfumées, plus foncées vers l'extrémité; sternum, abdomen, brun-foncé; segments abdominaux à la face inférieure finement bordés d'ocre; métasternum ocre; pattes ocre-brun, une ligne brun foncé le long du côté externe des tibias antérieurs et médians; cuisses postérieures brunes.

Longueur, 6·5 mm.; élytres étendus, 13 mm.

Habitat : Ecuador, Paramba, 3,500 ft., iii.1897 (*Rosenberg*).

Les *T. seguyi*, Lallemand, *caligata*, *picea*, *minuscula* et *ohausi*, Jacobi font partie de ce genre.

59. **Tomaspis versicolor,** sp. nov.

Vertex brun, antennes noires à soie terminale jaune; yeux gris tachés de noir; pronotum de trois couleurs, bords latéraux très largement jaunes, entre les yeux une grande tache brune, qui à la fin du tiers antérieur se retrécit et s'étend jusqu'au commencement du quart postérieur, son extrémité est arrondie, enfin plus de la moitié postérieure est rouge, le brun et le rouge ne se touchent pas, le jaune des bords latéraux, se continuant en une fine bande, s'insinue entre les deux autres couleurs et entoure complètement la brune; élytres brun-clair, le long du bord externe brun-foncé, une large bande d'un blanc légèrement brunâtre; front jaune; rostre noir; sternum, abdomen et pattes, ocre; tibias antérieurs et médians, tarses postérieurs, brun-foncé; élytres, pronotum, recouverts d'une villosité blanchâtre, dense.

Front globuleux, fortement renflé, sans carène médiane, à stries transversales peu profondes; voisin de *T. flavilatera* Urich; élytres presque trois fois aussi longs que larges, à nervures très peu saillantes; médian et cubitus réunis vers la base du corium.

Longueur, 10 à 11 mm.

Habitat : Guatemala (*G. C. Champion*).

THE RHOPALOCERA OF THE THIRD MOUNT EVEREST EXPEDITION (1924)

By N. D. Riley.

[Read March 2nd, 1927.]

In the following list of the Rhopalocera collected on the Third Mount Everest Expedition (1924), only those species are dealt with which occurred within Tibet. Major Hingston, who is much to be congratulated upon the results of his collecting, also secured a number of specimens before reaching the Tibetan frontier, the most interesting of which is probably a female of the very rare *Papilio plutonius pembertoni*, Moore, but as the interest of the collection centres more particularly in the Tibetan material it has been considered unnecessary to include the other in the present paper.

Twelve species or subspecies have been added to the list of captures made by the previous Expeditions, two being due to a revision of those lists in the light of the captures on the 1924 Expedition, viz. *Papilio machaon everesti* nov. and *Colias nina hingstoni* nov. The other ten are: *Parnassius simo acconus*, *P. acdestis lathonius*, *Argynnis altissima*, *Vanessa antiopa yedanula*, *Pararge masoni*, *Lycaenopsis argiolus jynteana*, *Lycaena dis errans* nov., *Lampides boeticus*, *Carterocephalus avanti* and *Taractrocera danna*. The three new subspecies are described in the present paper; the total number of species of Rhopalocera so far obtained by the three Expeditions is fifty.

In the course of a review of the paper giving the results of the previous Mt. Everest Expeditions Dr. Seitz * examines at some length our knowledge of the boundaries of the palearctic zone, pointing out, which was indeed evident from the results of previous expeditions into Southern Tibet, that the boundary runs along the southernmost and highest of the Himalayan ranges, not, as had sometimes been thought, along the inner range running through South Tibet. In order to fix the actual position of the barrier between the palearctic and the Indian faunas along this range much more detailed knowledge than is at present available will be required. It will probably be found to coincide with the altitude contours between 8–12,000 ft. in the N.W. Himalayas, gradually rising to 12–15,000 ft. in the east.

It is, however, in the mountainous country to the east of Sikkim, in S.E. Tibet and W. China, that the greatest difficulty in fixing an approximate boundary arises. Yet to attempt to overcome the difficulty by including the whole of China, Formosa and the Liukiu islands in the palearctic zone, as has been done by Bang-Haas in the recently published *Novitates Macrolepidopterícae*, savours simply of begging the question. In S.E. Tibet, Yunnan and Sze-chuan altitude will no doubt provide the key eventually, the palearctic elements being found to extend far to the south along the mountain ranges between which are enclosed the deep valleys colonised largely by Indian species. Throughout the rest of China there appears to be no evidence, as far as the Rhopalocera are concerned, to alter the approximate boundaries laid down by Wallace in 1876.

I have to thank Major Hingston for kindly adding a number of interesting extracts from his notes concerning many of the species; and Dr. E. A. Cockayne

* *Ent. Rundschau*, xl, pp. 13, 17, 21, 25, 30, 33 (1923).

for a detailed description of a gynandrous *Colias fieldii* from the Rongshar Valley.

Note. (1) An asterisk (*) indicates that the species was obtained on the 1921 Expedition; a dagger (†) that it was obtained in 1922. An account of the collections made on these Expeditions was published by the writer in *Trans. Ent. Soc.*, 1922, pp. 461–483 (1923).

(2) References are only given in the case of a species not referred to in the accounts of the earlier Expeditions.

Papilionidae.

*†**Papilio machaon,** L.

The very interesting series of this species brought back by the Mt. Everest Expedition is divisible into three groups :

(a) *P. machaon sikkimensis*, Moore.

Sikkim : Chumbi Valley, 11,000 ft., 2.iv.24, 1 ♂, 10,000 ft., 16.vi.24, 1 ♂; Tangu, 11,500 ft., 26.iv. 24, 2♀.

Tibet : Yatung, 10,000 ft., 4.iv.24, 1 ♂, 16.iv.24, 1 ♂, 11,000 ft., 25.vii.24, 1♀.

(b) *P. machaon everesti*, ssp. nov.

P. machon sikkimensis, Riley, Trans. Ent. Soc., 1922, p. 479 (1923) (2 ♂♂ taken on 1922 Mt. Everest Expedition).

Tibet : Rongbuk Glacier, 15–17,000 ft., 31.v–16.vi.24, 3 ♀.

♂♀. Intermediate between *P. m. asiatica* and *P. m. sikkimensis.* General coloration and pattern-development as in the former, but the ground-colour rather deeper ochreous, the submarginal band on fore-wing not thickly connected to the bar at cell end by way of the intervening veins; tornal red spot of hind-wing surmounted by narrow black crescent which separates it from the blue crescent immediately above.

(c) *P. machaon asiatica*, Men.

P. machaon race *sphyrus*, Bingham, ii, p. 36.
P. machaon asiatica, Seitz, ix, p. 46; Evans, Keys, p. 239 (1923).

Tibet : Rongshar Valley, 11–13,000 ft., 23.vi–1.vii.24, 6 ♂.

The Rongshar Valley lies to the west of Mt. Everest, Rongbuk to the north, and the remaining localities to the east, leading down to Sikkim. The western *P. machaon asiatica* has a moderately deep yellow ground-colour with rather narrow black markings and the blue lunule surmounting the tornal red eye-spot not separated from it by a black line. It occurs throughout the N.W. Himalayas, but the Rongshar Valley must certainly be its most easterly habitat, for the 3 ♀ *machaon* taken at Rongbuk (ssp. *everesti*), although retaining the ground-colour of *asiatica* in a slightly darkened form, and the markings of that subspecies, have the black line above the tornal ocellus fully developed. As soon as Yatung is reached, however, travelling east, even these intermediates have disappeared, their place being taken by fully developed *sikkimensis*. The actual transition zone between the two subspecies would appear to lie in the neighbourhood of Mt. Everest itself; possibly it occupies most of the very high plateau region in the immediate neighbourhood, and to the north of Mt. Everest. The approximate distances as the crow flies, from the Rongbuk Glacier, the habitat of *everesti*, to the Rongshar Valley (*P. machaon*

asiatica) on the one hand, and the Chumbi Valley (*P. machaon sikkimensis*) on the other, are respectively only about 30 and 130 miles. Although the habitat of *P. m. sikkimensis* is a comparatively restricted one, that of *P. m. asiatica* is very extensive, and consists mainly of very mountainous regions. Under these circumstances it is not surprising that the interposition of the highest tract of country in the whole Himalayan range should be necessary to form an effective barrier between the two subspecies under discussion.

Major Hingston remarks of this species: "*P. machaon* was one of the visitors to the Everest base-camp, observed as high as 17,000 feet. The different appearance in the forms of *P. machaon* was apparent even to field observation. The area in which *P. machaon sikkimensis* was taken consisted of deep valleys, heavily wooded, warm and sheltered from wind. The territory around Rongbuk occupied by *P. machaon everesti* was cold, exposed, windswept and bare of all vegetation larger than Alpine flowers. The part of the Rongshar Valley occupied by *P. machaon asiatica* was comparatively barren and resembled that of Rongbuk rather than Sikkim. The impression in the field was that the difference in form was in some way dependent on the corresponding types of territory. I feel sure that the intermediate forms around Rongbuk were stronger on the wing and more difficult to capture than those inhabiting the sheltered valleys of Sikkim. Strong flight would be more necessary for them in order to contend with the heavy winds."

*Parnassius epaphus everesti, Riley.

Tibet: Tinki La, 16,500 ft., 18.vii.24, 1 ♂.

The capture of this specimen considerably extends the known range of this subspecies. The original series came from the neighbourhood of the Rongbuk Glacier, which connects via the Dzakar Chu with the Phung Chu, another tributary running down to the latter from the neighbourhood of Tinki La. The distance separating Tinki La from the Rongbuk Glacier is about 75 miles in a direct line, or 100 miles via the valleys indicated.

*†Parnassius acco gemmifer, Fruhst.

Tibet: Kampa Dzong, 17,000 ft., 17.vii.24, 1 ♀; Dongka La, 16,500 ft., 18.vii.24, 1 ♀; Phari, 16,000 ft., 19.vii.24, 1 ♂ 1♀.

P. simo acconus, Fruhst.

P. simo moelleri, Bingham, i, p. 130.
P. simo acconus, Seitz, ix, p. 110; Evans, Keys, p. 245 (1923).

Tibet: Phuse La, 16–17,000 ft., 19.vi.24, 3 ♂, 3.vii.24, 1 ♂ 1 ♀.

The specimens taken on 19th June are perfectly fresh, and would seem to indicate that the species was then only just emerging. The July ♂ is in a very battered condition, but the female comparatively fresh.

Fruhstorfer's name has four years' priority over *moelleri*, Bingham.

†P. hannyngtoni, Avinoff.

Tibet: Tuna, 14,500 ft., 11.iv.24, 1 ♂; Pang La, 17,000 ft., 9.v.24, 1 ♂ 1 ♀; Rongbuk, 16,000 ft., 15.v.24, 1 ♂; Lamna La, 17,000 ft., 17.vi.24, 1 ♀; Kyetrak, 15,000 ft., 18.vi.24, 2 ♂; Phuse La, 16,000 ft., 19.vi.24, 1 ♀.

The Kyetrak record in particular very considerably extends the known

range of this remarkable little species, as Kyetrak lies some 27 miles almost due N.W. of Mt. Everest, and 150 miles W. of the Chumbi Valley, whence the species was first obtained. A specimen in the B.M. from Dzara (Tsangpo Valley) taken by F. Kingdon Ward further extends the known range by nearly 100 miles in the opposite direction.

***†P. hardwickii,** Gray.

Sikkim : Jelap La, 13,000 ft., 1.iv.24, 3 ♂ 3 ♀.
Tibet : Phari, 14,000 ft., 21.vii.24, 2 ♀.

The three pairs from Jelap La exhibit remarkable variation in size. One male and two females have about the normal wing expanse; one female, however, has a fore-wing length of only 17 mm., and two males are very little larger. In size, and owing to the smallness of their markings, these two males have a marked superficial resemblance to *P. hannyngtoni*.

P. acdestis lathonius, Bryk.

Parnassius var. *lathonius*, Bryk, Arch. Naturg., lxxix, A 6, p. 123 (1913).
P. delphius latonius, Evans, Keys, p. 244 (1923).

Tibet : Phuse La, 16,000 ft., 19.vi.24, 1 ♀.

Another race of this species was wrongly recorded in the account of the earlier Mt. Everest collections as *P. delphius lampidius*. *P. acdestis* and *P. delphius* are quite distinct species.

Major Hingston has kindly supplied the following interesting notes upon the various species of *Parnassius* obtained on the Expedition.

"*Parnassius hannyngtoni*. Met with in the barest and most inhospitable places. They prefer the windswept passes. Seldom seen in the plateau. *P. hannyngtoni* was a visitor to the Everest base-camp; but not seen above 17,000 feet. It was seen alighting on the ice of the Kyetrak Glacier. Its flight is feeble and it is easily swept about by the wind. It escapes being blown away by its unwillingness to fly except when the air is comparatively calm. When at rest it spreads its wings and flattens them down tight against the ground. High-altitude moths have a similar habit which probably prevents them from being swept away. The comparative strength and stiffness of the wings of *Parnassius* may be another adaptation to the rough conditions experienced at these great heights.

"*Parnassius acco gemmifer*. Met with only near the summit of high passes in the vicinity of Khampa Dzong and Phari.

"*Parnassius simo acconus*. The specimens were taken on a small patch of moraine at the extreme head of the Rongshar Valley. They seemed as if confined to an area of a few hundred square yards and were met with nowhere else. This may support the impression drawn from the specimens that the species was then only emerging.

"*Parnassius hardwickii*. Not uncommon on the southern slopes of the Jelap La. Shy and not easy to capture. Likes to escape the wind by flattening itself on the ground usually on the lee side of a boulder."

Pieridae.

***Pieris brassicae nepaleneis,** Gray.

N. India : Darjeeling, 5,000 ft., 14.iii.24, 1 ♂, 7,000 ft., 17.iii.24, 1 ♂.

Sikkim : Rangli Chu, 4,000 ft., 29.iii.24, 1 ♂; Pedong, 4,000 ft., 28.vii.24, 1 ♀.
Tibet : Chumbi Valley, 11,000 ft., 2.iv.24, 1 ♀; Rongshar Valley, Tropde, 11,000 ft., 23.vi.24, 1 ♂; Chumbitang, 13,000 ft., 24.vii.24, 1 ♂.

All rather worn, and in general facies like the European spring brood. There is no suggestion of a seasonal difference between the March and July specimens of the lower levels, which presumably represent distinct generations, nor between these and specimens from higher levels. June to July appears to be the normal time of occurrence above about 10,000 ft. in this region, the species presumably being single-brooded at that altitude.

†**Pieris canidia canidia,** Sparm.

Tibet : Rongshar Valley, 10,000 ft., 24.vi.24, 1 ♀.

The single specimen from the Rongshar Valley is of the common, heavily marked form prevalent throughout the Himalayas, not referable to the Tibetan subsp. *minima*, Verity, which was obtained at Gyangtse in such numbers by the Tibet Expedition of 1904. It was obtained at the head of the Rongshar Valley, which is a deep gorge cutting right through the main range of the Himalayas.

"One of the few butterflies taken in the Rongshar Valley. This valley is a narrow gorge passing from Tibet into Nepal. In its upper and bare parts a few butterflies were met with; but in the lower tracts, which were choked with vegetation, there was scarcely a butterfly to be seen. In fact, compared with the wealth of vegetation, all animal life in the lower part of the Rongshar Valley was remarkably scarce."—R. W. G. H.

†**Pieris melete melania,** Röber.

Sikkim : Tangu, 11,500 ft., 26.iv.24, 2 ♂.
Tibet : Yatung, 11,000 ft., 4.iv.24, 1 ♂; Chumbi Valley, 11,000 ft., 22.vii.24, 3 ♀.

All these specimens, except two of the females, are perfectly fresh; the localities from which they came are by no means widely separated; the dates, however, cover a period of nearly four months. It would be interesting to know how many broods are represented by the series : two or only one. June and July are usually considered to be the months for this subspecies, but generally at rather greater altitudes. Major Hingston states that these specimens were "all taken in well-wooded valleys below the tree limit. Not seen on the exposed plateau."

***P. dubernardi chumbiensis,** de Nicev.

Tibet : Phari, 14,000 ft., 21.vii.24, 1 ♂.

Recorded in the account of the 1921 collection as *Pieris chumbiensis*. A single very worn ♂.

***Colias berylla,** Fawcett.

Tibet : Ling-ka, 14,000 ft., 15.vii.24, 1 ♀.

†**Colias nina hingstoni,** subsp. nov.

Colias nina, Riley, Trans. Ent. Soc., 1922, p. 480 (1923).

Tibet : Kyishong, 14,500 ft., 10.vii.24, 1 ♂ 3 ♀; Rongbuk, 15,000 ft., 16.vi.24, 1 ♂.

♂♀. Somewhat intermediate between *C. nina* and *C. ladakensis*. Pattern of the upperside definitely as in *C. nina nina*, except for an increase in the size of the submarginal yellow markings of both wings. Ground-colour of upperside as in *C. ladakensis*, except for the area enclosed between inner margin, postdiscal black band and the median vein (including posterior portion of cell) of fore-wing, which is orange-coloured as in *C. nina nina*; orange cell-spot of hind-wing as in *C. nina*. The underside, in the darkness of the green ground-colour, which is grey-green rather than the yellow-green of *C. nina* and not so much paler marginally as in *C. nina*, and in the consequently more prominent internervular marginal yellow streaks, shows a more definite approach to *C. ladakensis*.

The types are from Kyishong. The single male from Rongbuk is slightly atypical as to its underside, showing in that respect a closer affinity to typical *C. ladakensis*, although the upperside is quite like that of *hingstoni*. The much darker discal area of the hind-wing in this specimen, in *hingstoni*, and in typical *nina*, serves as a ready means of distinguishing the three from *ladakensis*.

C. nina and *C. ladakensis* appear to be two very distinct species, but the discovery of *hingstoni* and of the form recently described as *C. ladakensis* f. *flava* (Riley, *Ent. Mo. Mag.*, lxii, p. 277 (1926)), both of them exhibiting intermediate characters (though of different nature) suggests that when the region lying between N. Kumaon and Mt. Everest is better known, it may be possible to trace a complete transition from one to the other. The position at present is that in N. Kumaon typical *ladakensis* and its orange form *flava* are found; near Mt. Everest itself a form like *ladakensis* on the underside but with the upperside of *hingstoni* occurs; further east at Kyishong and Phung Chu typical *hingstoni* only is met with; and at Gyangtse only *nina* occurs. The transition indeed is already almost complete.

*†**Colias fieldi edusina,** Feld.

Darjeeling : 7,000 ft., 12.iii.24, 1 ♂.

Sikkim : Gnatong, 10,000 ft., 31.iii.24, 1 ♂; Tangu, 11,500 ft., 26.iv.24, 1 ♂ 1 ♀.

Tibet : Rongshar Valley, 10–12,000 ft., 24–30.vi.24, 3 ♂ 1 ♀; Tropde, 11,000 ft., 23.vi.24, 1 ♂; Yatung, 10,000 ft., 24.vi.24, 1 ♂; Tinki Dzong, 14,000 ft., 14.vii.24, 1 ♀.

" The specimens from Tinki Dzong and the head of the Rongshar Valley are from the bare mountainous country above the level of the trees."—R. W. G. H.

The only specimen in this series that is of any particular interest is a gynandromorph from the Rongshar Valley, which has been described very kindly by Dr. Cockayne as follows :—

On the upperside of the left fore-wing a stripe of female scaling runs from the base through the middle of the discoidal cell to the termen. It is slightly curved and broadens as it passes outwards, so that beyond the disc the anterior part of it lies in front of 5 and near the termen the posterior part lies behind 4. The basal part is very dark grey and hairy, but just internal to the discal spot and from the discal spot to the marginal band the scales are pale yellow with some admixture of black ones. The greater part of the margin between 4 and 5 lacks the dusting of long yellow scales so conspicuous in the male portion, and has a small oval patch of short pale yellow scales in it; at one point the black extends much further inwards than elsewhere. On both sides of 3 there is a pale yellow area sprinkled with black and in the margin, which becomes a little wider at this point, is a plain black patch, the whole forming a large diamond-shaped area of female scaling. A line of black scales runs from 3 to the margin and looks like an extra nervure, but no nervure is present. Another large area of pale yellow and black scales lies along 1 and extends in a semicircle more than halfway across cell 2, and continuous with it is a com-

pletely black area in the margin. On the underside the left discoidal spot has a larger pale centre than the right, and the colour of the scaling in the cell differs a little from that on the other side. Presumably this too is female. The other three wings are of male coloration, and the abdomen including the external genitalia also appears to be entirely male.

The black border in the female of *C. fieldi* is wider than in the male and is often devoid of yellow dusting. In these respects the female part of the gynandromorph agrees exactly with a typical female. And, although rather small, the oval yellow spot is in the correct position for one of the normal spots in the female margin. The ground-colour, however, is most unusual. The yellow is as pale as that of the spots in the margin instead of being orange like the male, and the basal area is remarkably extensive and dark.

Nymphalidae.

*Argynnis lathonia issaea, Dbl.

A. lathonia race *issaea*, Bingham, i, p. 441.
A. lathonia issaea, Seitz, ix, p. 514; Evans, Keys, p. 89 (1924).

Sikkim: Lachen R., 11,000 ft., 26.iv.24, 1 ♂.
Tibet: Chumbi Valley, 11,000 ft., 2.iv.24, 1 ♀, 22.vii.24, 1 ♀; Rongshar Valley, 12–15,000 ft., 30.vi–2.vii.24, 4 ♀; Tropde, 11,000 ft., 22.vi.24, 2 ♀.

The specimens from the Rongshar Valley and Tropde are all unusually pale, especially their fore-wings. Major Hingston writes that these "were taken on exposed hillsides devoid of all but alpine vegetation. The others were captured in wooded valleys."

*†Argynnis clara manis, Fruhst.

Tibet: Phari, 16,000 ft., 19.vii.24, 1 ♂, 14,000 ft., 21.vii.24, 1 ♂.

Argynnis altissima, Elwes.

A. altissima race *altissima*, Bingham, i, p. 445.
Boloria altissima altissima, Seitz, ix, p. 513.
A. altissima, Evans, Keys, p. 90 (1924).

Tibet: Rongshar Valley, 15,000 ft., 2.vii.24, 1 ♂; Phari, 14–16,000 ft., 19–21.vii.24, 6 ♂.

It is rather remarkable that this little species, so common in the Chumbi and Teesta Valleys, was not obtained by either of the previous Expeditions.

The single specimen from the Rongshar Valley is interesting in that it shows a very distinct approach, particularly in the coloration and markings of the underside of the hind-wing, to *A. altissima mackinnoni*, de N., from Kumaon, as was to be expected. Major Hingston remarks that "the specimens from the Rongshar Valley and Phari were taken in exposed and treeless country quite different from the well-wooded valleys of Chumbi and Teesta."

*†Melitaea sindura tibetana, Fawcett.

Tibet: Rongshar Valley, 15,000 ft., 2.vii.24, 1 ♂ 1 ♀; Phuse La, 16,500 ft., 3.vii.24, 1 ♂; Dingka La, 16,000 ft., 18.vii.24, 2 ♂; Phari, 14–16,000 ft., 19–20.vii.24, 18 ♂, 2♀.

The series from Phari and Dingka La exhibits only a moderate amount of variation, hardly any showing any approach to ssp. *sikkimensis*, Elwes. The ♂ and ♀ from the Rongshar Valley differ somewhat from these, but afford too

slender evidence upon which to assume their subspecific distinction. Major Hingston notes that this species was found "only in bare country at considerable altitudes. Usually met with in the ascent to high passes."

***†Vanessa ladakensis,** Moore.

Tibet: Gautsa, 13,000 ft., 5.iv.24, 1 ♂; Phari, 14,300 ft., 7.iv.24, 1 ♂; Rongbuk, 16,500 ft., 27.v.24, 1 ♂; Lamna La, 17,000 ft., 17.vi.24, 1 ♀; Phuse La, 16,000 ft., 19.vi.24, 1 ♂.

"Appears to frequent higher altitudes than *V. cashmirensis*. Is strong and active on the wing and well able to cope with high-altitude winds. Was one of the visitors of the Everest base-camp. Sometimes observed alighting on the glacier. Also seen at Camp I, 18,000 feet. A Vanessid butterfly, almost certainly this species, was seen carried by the wind over Camp III, at a height of 21,000 feet. On the same day a moth and a humble-bee were seen swept by a gale to the same height. This was the greatest altitude at which insects were observed. It may be noted that plant-life was not met with above 18,000 feet and that Attid spiders were found as permanent inhabitants at 22,000 feet."—R. W. G. H.

***Vanessa chinensis,** Leech.

Tibet: Shekkar, 14,500 ft., 9.vii.24, 1 ♀; Kyishong, 14,500 ft., 10.vii.24, 1 ♀.

The entire absence of the large pale yellow area on the underside of the fore-wing in this reputed subspecies of *V. urticae*, and in *V. rizana* § from the Western Himalayas, seems to link these two together and separate them definitely from *V. urticae*.

"Found on the exposed plateau, bare of large trees, but well clothed in grass and Alpine flowers. Not seen in very barren places or on high passes."—R. W. G. H.

***†Vanessa caschmirensis aësis,** Fruhst.

Sikkim: Gnatang, 10,000 ft., 31.iii.24, 3 ♂; Jelap La, 13,000 ft., 1.iv.24, 6 ♂; Tsomso, 13,000 ft., 20.iv.24, 1 ♂; Lachen R., 11,500 ft., 26.iv.24, 1 ♂.
Tibet: Chumbi Valley, 11,000 ft., 2.iv.24, 3 ♂.

In the account of the 1921 Expedition attention was called to the occurrence of these three Vanessids in close proximity. The 1924 collections show that whilst *V. chinensis* was obtained in the middle of the area occupied by *V. ladakensis*, the area occupied by *V. caschmirensis* was not invaded by either of the other two, nor, in fact, were any two of the three species ever met with in exactly the same locality.

Vanessa antiopa yedanula, Fruhst.

Vanessa antiopa, Bingham, i, p. 370.
V. antiopa yedanula, Seitz, ix, p. 527; Evans, Keys, p. 87 (1924).

Tibet: Yatung, 11,000 ft., 3–4.iv.24, 2 ♂.

Both very battered, and with the borders almost white but yet clearly more heavily black-scaled than in typical *V. antiopa*.

"Taken in the sheltered, well-wooded valley."—R. W. G. H.

§ Although it is alleged by several authors that *V. rizana* occurs in Sikkim and the neighbouring parts of Tibet, the statement would appear to be inaccurate, as amongst the very large series of Vanessas in the B.M. from these regions, no specimens of *V. rizana* have so far been received.

†Polygonia interposita agnicula, Moore.

Tibet : Chumbi Valley, 11,000 ft., 2.iv.24, 2 ♂ 1 ♀; Yatung, 11,000 ft., 11.iv.24, 1 ♂ 1 ♀.

†Pyrameis cardui, L.

Tibet : Chumbi Valley, 11,000 ft., 2.iv.24, 1 ♂ 2 ♀; Yatung, 10,000 ft., 16.iv.24, 1 ♂ 1 ♀; Phuse La, 16,500 ft., 3.vii.24, 1 ♂.

"Seen both in the wooded valley and on the high wind-swept Tibetan passes."—R. W. G. H.

Satyridae.

Pararge masoni, Elwes.

Lethe masoni, Bingham, i, p. 84.
Satyrus masoni, Seitz, ix, p. 311.
Pararge masoni, Evans, Keys, p. 537 (1923).

Tibet : Chumbi Valley, 11,000 ft., 22.vii.24, 2 ♂; Yatung, 10–13,000 ft., 24.vii.24, 3 ♂.

***Paroeneis bicolor,** Staud.

Tibet : Lingka, 14,000 ft., 15.vii.24, 1 ♀.

***†Paroeneis sikkimensis,** Staud.

Tibet : Phari, 14,000 ft., 21.vii.24, 2 ♂.

***Paroeneis grandis,** Riley.

Tibet : Rongshar Valley, 13,000 ft., 2.vii.24, 1 ♂.

Lycaenidae.

Lycaenopsis argiolus jynteana, de Nicev.

Cyaniris jynteana, Bingham, ii, p. 331.
Lycaenopsis argiolus sikkima, Seitz, ix, p. 871.
L. argiolus jynteana, Evans, Keys, p. 344 (1925).

N. India : Darjeeling, 7,000 ft., 9.iii.24, 1 ♀.
Sikkim : Lachen R., 8,000 ft., 25.iv.24, 2 ♂.
Tibet : Yatung, 11,000 ft., 25.vii.24, 1 ♂; Chumbitang, 13,000 ft., 25.vii.24, 1 ♀.

The July specimens are of the form called *sikkima* by Moore.

***†Lycaena younghusbandi,** Elwes.

Lycaena younghusbandi, Bingham, ii, p. 338; Seitz, ix, p. 928; Evans, Keys, p. 347 (1925).

Tibet : Tingri, 15,000 ft., 6.vii.24, 1 ♂; Kyishong, 14,500 ft., 9.vii.24, 1 ♀.

***†Lycaena pheretes pharis,** Fawcett.

Tibet : Phari, 16,000 ft., 19.vii.24, 5 ♂; Tinki La, 15,500 ft., 2 ♂.

***Lycaena janigena,** Riley.

The single female recorded under this name in the Appendix to the previous list—taken at Phari on 19.vii.22 by Major Norton, proves on closer inspection

to be not this species at all, but a somewhat aberrant female of *L. pheretes pharis*.

***Lycaena morsheadi,** Evans.

Tibet : Rongshar Valley, 15,000 ft., 2.vii.24, 4 ♂; Phuse La, 16,500 ft., 3.vii.24, 1 ♂.

The types of this species having been generously presented to the British Museum by Colonel Evans, in accordance with his commendable policy of making over all actual types to that institute, it transpires that the specimen described as the ♂ is actually a female. This discovery, together with the capture by Major Hingston of five undoubted male specimens, permits of a better appreciation of the differences between this species and *L. janigena*, Riley.

The ♂ *morsheadi* agrees on the underside exactly with the ♀, except that the wide white submarginal fascia on the fore-wing may be reduced or absent. The upperside is deep purplish blue with a roughish but silky appearance, almost exactly as in *L. pheretes lehana* and *pharis*; indeed it is indistinguishable from the latter on the upperside, for it has the same narrow fore-wing marginal black shading, and broad hind-wing black border.

Morsheadi can be distinguished at once from the male of *L. janigena* by its less rounded fore-wing and the narrow terminal black shading of that wing. In *L. janigena* the width of the black border is almost the same on both wings—nearly 2 mm. The underside of *janigena* differs by having the white markings rather smaller and the chocolate ground-colour in consequence more conspicuous than in *morsheadi*. These differences are noticeable at once; none the less the possibility of *janigena* and *morsheadi* being but subspecies of one species should not be overlooked. Their habitats are not very widely, but yet most effectively separated, and it seems very probable that their differences are but the product of isolation, for they are closer to one another than to any other nearly related species.

" Met with only in the Rongshar Valley, at high altitudes on moraines and bare mountain slopes."—R. W. G. H.

Lycaena dis errans, ssp. nov.

Tibet : Phari, 14,000 ft., 20.vii.24, 1 ♂ (Holotype).

♂. *Upperside* very dark brown, faintly sprinkled with pale grey-green scales; a prominent white spot on discocellulars of each wing; cilia long and pure white, with a minute, intensely black dot at the extremity of each vein. *Underside*, fore-wing ground-colour dark brown, faintly greenish; a large white spot at cell-end and another immediately proximal to it; a discal series of six large, contiguous, suboval white spots, the lowest, in area one, grey-tinted, the next three with their outer edges in line with wing apex, the 4th to 6th with their outer edges in line with tornal angle; above these, two narrow wedge-shaped white marks against costa; narrow white submarginal band, interrupted in area 2, and outwardly grey-edged; cilia as above. Hind-wing ground-colour ferruginous, basally overlaid with hoary grey scaling, and distally, except for a short oblique dash in area 2 terminating on the margin, replaced by a white, grey-shaded marginal band that for the most part is fused with the discal spots; discal spots seven in number, large, contiguous, white and very irregularly arranged, those in areas 2–4 in a row directed towards the extremity of vein 6, and at an acute angle to the three above; of the latter the upper two (in areas 6 and 7) are rather detached from the remainder and placed almost vertically one above the other; the lowest spot (in area 1*c*) much displaced outwardly; a very large

white spot at cell-end; another, rather smaller, immediately above it; and three, smaller, arranged in a triangle below it against abdominal margin; cilia as on fore-wing.

Length of fore-wing, 11 mm.

This curious little form seems clearly to be related to *Lycaena dis*, Gr. Gr.§ On the other hand, it appears at first sight to be *L. luana*, Evans. The probability indeed is that all three are races or subspecies of one species, although both *errans* and *luana* are markedly smaller than *dis*. The upperside of *luana* is distinctly greyish, and the spot at the cell-end on the fore-wing is larger than in either *dis* or *errans*, and crescent-shaped. On the underside *luana* differs from the other two in having the fore-wing almost uniformly grey, with such traces of markings as are present arranged, it is true, as in *dis* and *errans*, but much smaller. In the tone of its underside ground-colour *errans* is intermediate between *dis* and *luana*, but inclining rather to the latter.

It is remarkable that this little form has not been met with before at Phari, as that place has been comparatively well collected. *L. dis* was described from a single specimen taken in Amdo; all the specimens of *luana* taken by Major Bailey came from S.E. Tibet, some distance S.E. of Lhasa.

*†**Polyommatus arene,** Fawcett.

Lycaena stoliczkana arene, Seitz, ix, p. 928.
Polyommatus eros arene, Evans, Keys, p. 349 (1925).

Tibet: Rongshar Valley, 12,000 ft., 30.vi.24, 1 ♂ 1 ♀; Tingri, 15,000 ft., 6.vii.24, 7 ♂ 2 ♀; Shekkar, 14,500 ft., 8–9.vii.24, 2 ♂ 2 ♀; Kyishong, 14,500 ft., 9.vii.24, 4 ♂ 1 ♀; Chiblung, 14,500 ft., 12.vii.24, 6 ♂ 4 ♀; Tinki Dzong, 14,000 ft., 14.vii.24, 1 ♂; Ling-ka, 14,000 ft., 15.vii.24, 1 ♀.

"The commonest Lycaenid on that portion of the plateau traversed by the Expedition. Found wherever vegetation becomes at all luxuriant."—R. W. G. H.

Lampides boeticus, L.

Polyommatus boeticus, Bingham, ii, p. 432; Seitz, ix. p. 895.
Lampides boeticus, Evans, Keys, p. 351 (1925).

Tibet: Yatung, 11,000 ft., 25.vii.24, 1 ♂.

Hesperiidae.

Carterocephalus avanti, de Nicev.

Pamphila avanti, Seitz, i, p. 345.

Tibet: Yatung, 11,000 ft., 4.iv.24, 1 ♂.

Taractrocera danna, Moore.

Taractrocera danna, Seitz, i, p. 346.

Tibet: Rongshar Valley, 11–12,000 ft., 29–30.vi.24, 4 ♂ 1 ♀.

§ *Hor. Ent. Soc. Ross.*, xxv, p. 453 (1891).

A NEW GENUS AND SPECIES OF THE STREPSIPTERA FROM SOUTH INDIA, *INDOXENOS MEMBRACIPHAGA*, GEN. AND SP. NOV.

By T. V. Subramanian.

(Communicated by Guy A. K. Marshall, C.M.G., D.Sc., F.R.S.)

[Read March 2nd, 1927.]

Plates XI–XII.

There is very little information on record about the Indian representatives of this extremely interesting group of insects. As far as the writer is aware, only two species have so far been definitely recorded from the Indian region. One is *Pyrilloxenos compactus*, Pierce, which has been recorded from both North and South India (1) as a parasite on species of Homoptera belonging to the different families Fulgoridae and Jassidae. The other, *Tachytixenos indicus*, Pierce, (2) is mentioned as parasitising a wasp, a species of *Tachytes*. Lefroy in his "Indian Insect Life" (3) makes mention of a *Xenos* without definitely saying what species it is; he simply quotes Horne that the wasp *Polistes hebraeus* is the host of a *Xenos*, and that the latter appears to exert a marked check on the wasp. Green (4) records a number of Ceylon forms, and Nurse (5) mentions having obtained a number of stylopised wasps of the genus *Tachytes* from Deesa (India). Besides these references no further information is available on these insects. This is certainly not due to their absence from this country, but because hardly any worker has interested himself seriously in this group. During the past few years the writer has been paying some attention to certain Jassids of economic importance, and incidentally the Strepsiptera found living in them and in other Homoptera attracted his attention. His paper on some natural enemies of the mango-hopper published in 1922 was the result of his earlier studies in that direction. Since then it has been possible to gather additional material and make further field observations on the bionomics of these insects. This paper is a description and a record of notes made on one of the forms collected some time back, which, in the opinion of the writer, exhibits some characters that easily separate it from all forms of Strepsiptera so far known.

In June 1923 while camping in North Mysore at a place called Sasalu, the author collected a number of stylopised Membracid bugs of the species *Otinotus pallescens*, Dist., and from these a number of male Strepsiptera were bred. With the idea of finding out the generic position of the insects, these specimens were compared with the descriptions of the genera and species and illustrations contained in the monographs (2) by D. Pierce, and the tabular synopsis of the Indo-Australian Strepsiptera of Karny (6). The insect appeared to be closely allied to *Crytocaraxenos* and *Pentozocera* of the super-family Halictophagoidea. In the structure of the head and thorax it resembles the former to a certain extent, and in the wing-venation the latter. In all other structural features, namely mouth-parts, legs and aedoeagus, the insect possesses definite characters of its own and stands quite apart from either of the two allied genera. Under the circumstances, it appears advisable to erect a new genus for the reception of this interesting Indian form. Apart from its struc-

tural features its host relationships are also remarkable, since so far no stylopised Membracid has been noted. The writer proposes to call the genus *Indoxenos*.

Indoxenos, gen. nov.

♂. Head emarginate behind and the frontal portion produced to form a broad ridge, on the sides of which are placed the antennae.

The antennae are stoutly built, seven-jointed, the first two normal, the second globular and much smaller than the first, the others laterally produced, the apices of the joints being of about equal width. The whole antenna is not longer than the width of the head. There is a small sensorial organ on the base of the fourth antennal segment.* The eyes pedunculate, the mandibles and maxillae arising at a much greater distance from the eyes than the length of the two joints of the maxillae. *Prothorax* band-like, much produced into the dorsal cavity of the head, with the notal portion trapezoidal and fitting into the emargination behind the head and with the sides invisible from above. The *mesothorax* consists of two pieces, the anterior semilunar, the posterior transverse, shorter on the median line than at the sides, with the posterior angles produced pleurally. *Metathoracic praescutum* keystone shape, the anterior broad and rounded, the posterior portion narrow and truncate. The scuta broad, oblique, the outer angles surpassing the praescutum very much, all the above pieces being separated from the scutellum by a deep narrow depression. The *scutellum* broader than long, irregular in outline, broader at base than praescutum, the sides behind the scuti concave, the anterior angles rounded, the posterior diagonally produced into peduncles and the apex rounded. The *wings* with seven primary veins from base: costa, subcosta, radial and medial and three anal. The medius is broken and there are two detached veins, one in front and another on the anal side, the latter arising almost in contact with the medius. *Postscutellum* stout, convex and slightly longer than the postlumbium, scutellum and metapraescutum together. *Aedoeagus* stout, with inflated base, sickle-shaped and ending in an acute point.

Genotype, the following :—

Indoxenos membraciphaga, sp. nov.

♂. 2·279 mm. in length, smoky-black in colour except the extremities of the appendages which are lighter in colour. The eyes and the expanded portion of the elytra piceous, the mandibles dark brown, the whole insect being covered with a silvery bloom in certain lights. The eyes pedunculate, the facets well separated with the interspaces hirsute. The two-jointed maxilla is much shorter than the mandible, the first joint narrow, about as long as the second joint which is flat and longer than broad, both joints thinly pubescent. In specimens cleared in potash and mounted in balsam, the epistome and labrum have the outline of an inverted triangle and appear to hang down as one piece with the vertex or labrum broad, rounded, highly chitinised and on a level with the maxillae. The mandibles are stout built, long, sharply pointed and meet before the mouth opening. The tibiae of the front legs are short, stout and almost triangular in shape with the vertex towards the femur. The tarsi are three-jointed, the first joint of the front legs is broad, as broad as the base of the tibiae, more or less oblong. The

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* Dr. Hofeneder of Austria, to whom the specimens were sent, says in a private letter: "On the base of the fourth antennal joint is indistinctly visible a sensorial organ similar to those I have described in *Mengenilla chobautii*. This organ is better visible from the underside, seen from above shining through. A similar organ I have described in a new Halictophagid from Sumatra (the publication will issue shortly). A similar organ I have found in a new Mengenillid from Algier."

abdomen is ten-segmented, with the eighth slightly produced before the ninth, the whole being covered with very fine hairs. The tenth segment is very stout. The aedoeagus pale-coloured, sickle-shaped with the underside of its base covered with minute hairs.

♀. The cephalothorax is yellowish to dark brown, tuberculate on the apical side, longer than broad, rounded at the sides of the head, the genital opening very much arched with its vertex below the middle of cephalothorax. The genital opening is entirely covered with a flap-like structure which exactly fits the contours of the opening and appears more or less like a valve. The surface of the cephalothorax is flat and even as far as the vertex of the genital opening, and from there it gradually slopes down towards the apex; mouth-opening fairly large and funnel-like, and in specimens cleared in caustic potash, another similar mouth opening of the adult female inside is noticed a little below the first. Mandibles are large with two teeth close together with the outer one short and blunt. The spiracles are placed in the sides in a slight projection immediately below the starting-place of the arch-like genital opening. Three genital tubes are found to enter the brood canal.

Measurement of female. (Taken with No. 2 Zeiss micrometer ocular and 16 mm. objective, 68 divisions = 1 mm. Specimens cleared in caustic potash and mounted in canada balsam.)

Width between spiracles	·324 mm.
Width at base	·294 mm.
Width at base of head	·220 mm.
Width between base of mandibles	·059 mm.
Length from base to vertex	·384 mm.
Length from spiracles to vertex	·294 mm.

Described from three males bred from *Otinotus pallescens*, Dist., in Sasalu, Mysore State, in June 1923, and three females out of a number collected at Sasalu in June 1923.

Triungulins. These are small, coloured deep yellow and with black pigmented eyes. These may be found crawling over the body of the hosts in large numbers after escaping out from the parent. The abdomen is ten-segmented with the last segment bearing a pair of long stylets and the ninth two very short ones.

The following are the measurements of (A) triungulins cleared in caustic potash and mounted in canada balsam, (B) fresh specimens mounted in glycerine.

	A.	B.
Length excluding stylets	·191 mm.	·279 mm.
Length of stylets	·073 mm.	·162 mm.
Width of thorax	·059 mm.	·073 mm.
Width of head	·044 mm.	·059 mm.
Width of abdomen	·059 mm.	·088 mm.

It may not be out of place here to mention that Pierce in his classification of the superfamilies of Strepsiptera (2), page 423, differentiates the Halictophagoidea from other families by the possession of only two genital tubes entering the brood canal in the female in addition to other characteristics. Dissection of a number of females of *I. membraciphaga* showed three genital tubes entering the brood canal. The genital tubes entering the brood canal in *Pyrilloxenos compactus* are also found to be greater in number than that mentioned by Pierce in his classification. The number of genital tubes entering

the brood canal cannot therefore be taken as one of the distinguishing characteristics of the superfamily HALICTOPHAGOIDEA.

The hosts, *O. pallescens*, Dist., were found breeding in large numbers on species of Cassia and Acacia plants attended by swarms of the black ant *Camponotus compressus* in Sasalu and on *Cajanus indicus* plants in Bangalore. From 10 to 15 per cent. of the hosts were found stylopised from June to October. Another Membracid bug *Oxyrachis tarandus*, Fabr., breeds in large numbers amidst colonies of *O. pallescens*, but not a single specimen has been found stylopised.

In conclusion I have to acknowledge my indebtedness to Dr. K. Kunhi Kannan, M.A., Entomologist, Mysore Department of Agriculture, for help and encouragement in the study of this interesting order of insects.

I am also greatly indebted to Dr. Karl Hofeneder of Innsbruck, Austria, for his very valuable suggestions, especially for his having drawn my attention to the presence of the sensorial organ referred to above.

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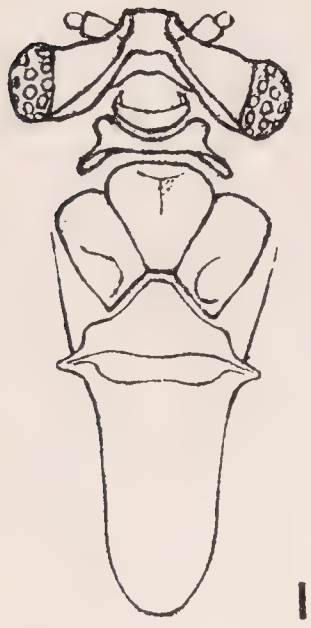

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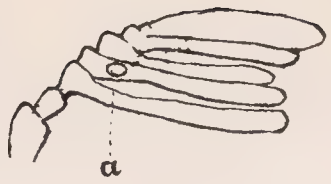

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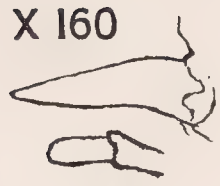

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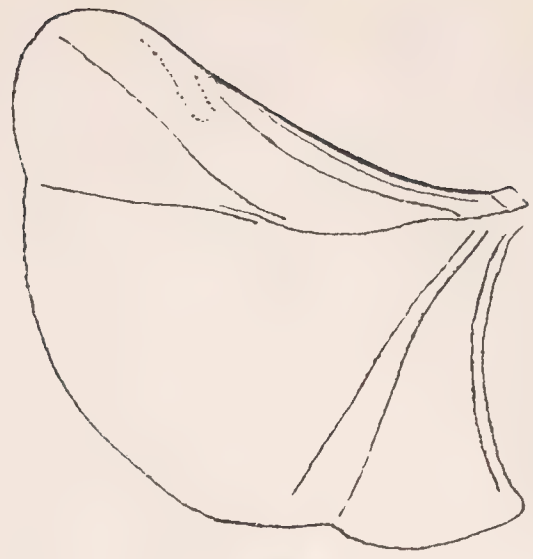

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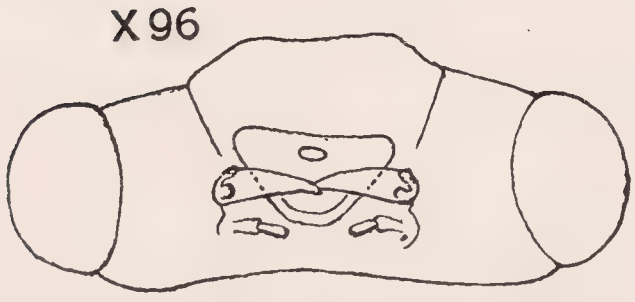

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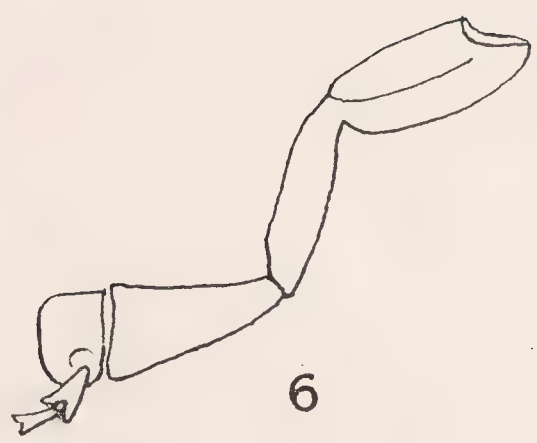

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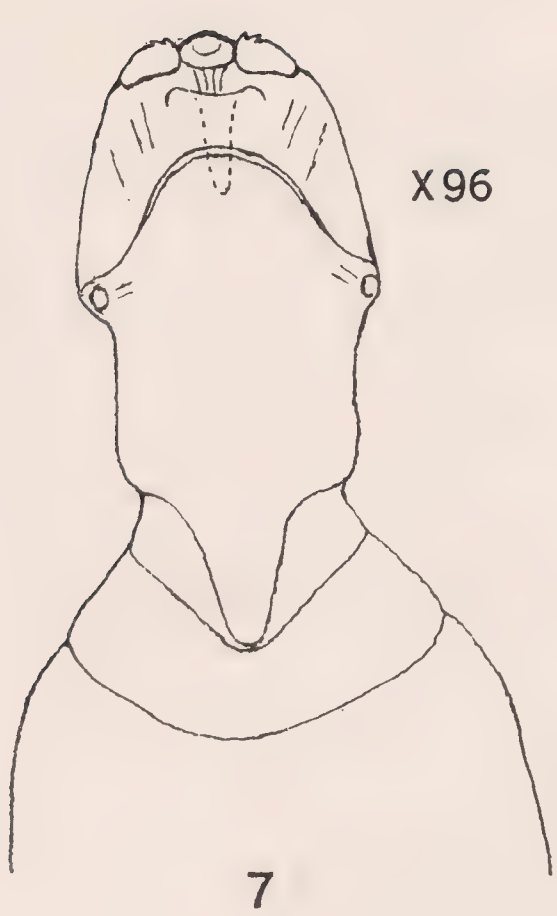

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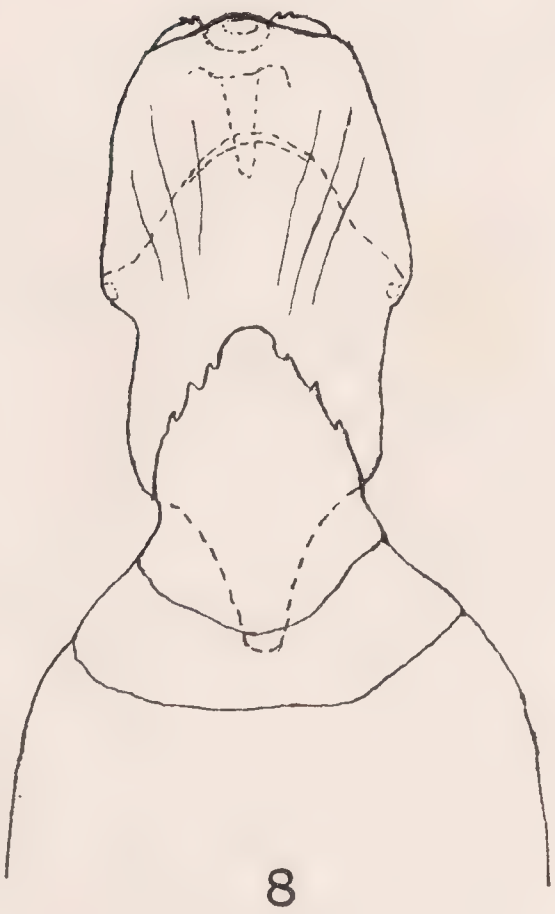

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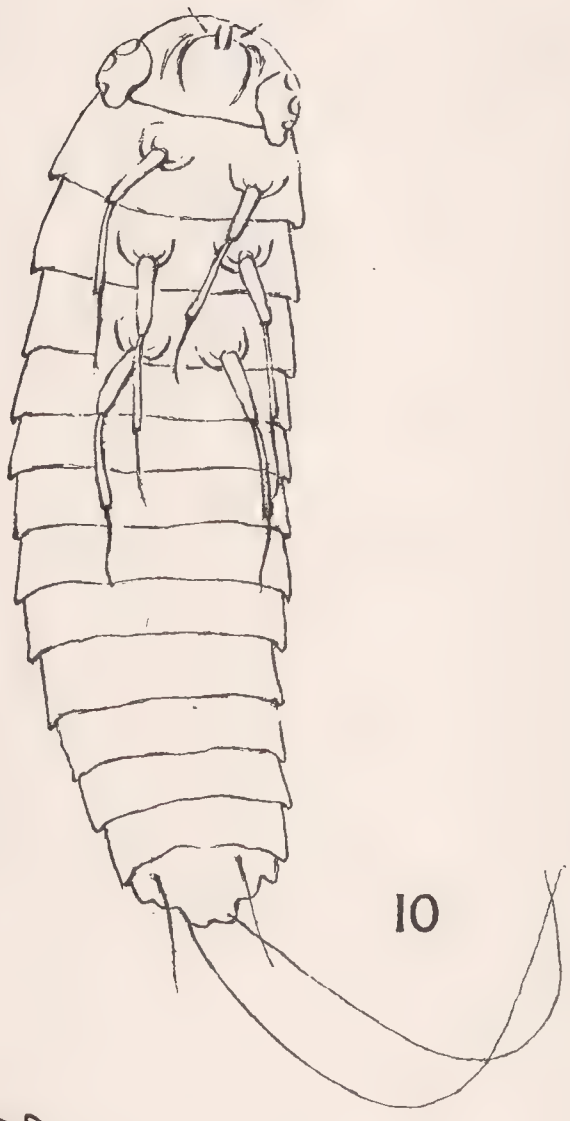

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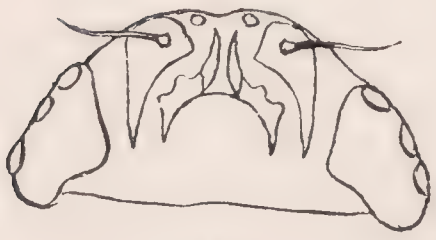

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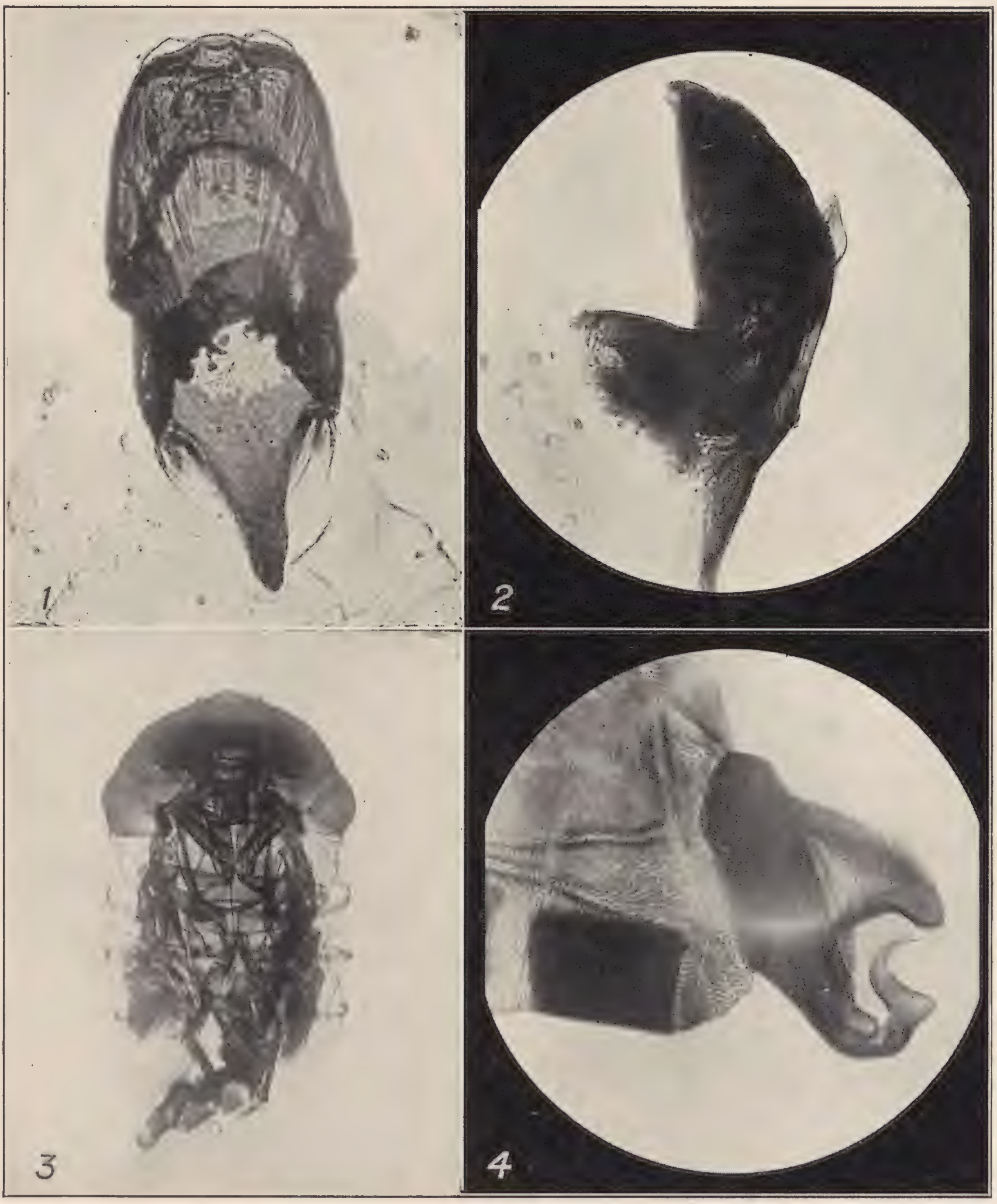
T. V. Subramanian, del. *Vaus & Crampton, Ltd.*

INDOXENUS MEMBRACIPHAGA gen. et sp. nov.
(STREPSIPTERA.)



T. V. Subramanian, photo. *Vaus & Crampton, Ltd.*

INDOXENUS MEMBRACIPHAGA gen. et sp. nov.
(STREPSIPTERA.)

Explanation of Plates XI–XII.

Indoxenos membraciphaga, gen. et sp. n.

Plate XI.

(All figures are much enlarged. Most of them have been drawn from specimens treated with caustic potash and mounted in xylol and balsam.)

Fig. 1. Dorsal view of head and thorax of male.
2. Antenna; (*a*) the position of the sensorial organ at the base of the fourth antennal segment.
3. Mandible and maxilla.
4. Wing.
5. Front view of the head of male showing the pharynx and the mouth-parts.
6. Anterior leg of male.
7. Cephalothorax of female, ventral view.
8. Cephalothorax of female, dorsal view.
9. Right mandible of female, very much enlarged.
10. Triungulin, ventral view.
11. Head and mouth-parts of the triungulin, very much enlarged.

Plate XII.

(Photomicrographs from specimens treated with caustic potash and mounted in xylol and balsam.)

Fig. 1. Cephalothorax of female, ventral view.
2. Cephalothorax of female, side view showing the foliaceous valve-like structure covering the genital opening, the anterior end slightly detached.
3. Pupa of male.
4. Side view of abdominal segments, posterior end showing the aedoeagus.

INSECT REMAINS FROM OIL SAND IN TRINIDAD

By K. G. Blair.

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[Read March 2nd, 1927.]

At the Meeting of the Society held on June 4th, 1924, Dr. Neave exhibited some insect remains found in a deposit of oil-bearing sand in Trinidad. Further material has since been received from Dr. H. G. Kugler, geologist to the Apex (Trinidad) Oilfields, Ltd., on whose holdings near Fyzabad the deposit is situated. This gentleman has very kindly furnished a report, appended hereto, on the geological aspects of the occurrence.

As Dr. Kugler states, when first exposed many of the beetles exhibit the colours almost of the living insect, but on exposure to air these colours soon disappear, leaving a uniform blackness. It is, however, noteworthy that such colours as are preserved appear to be those due to structural causes, *i.e.* fine laminae or striae in the structure of the chitin, such as the metallic colours of *Megacephala* and the olive-green of *Dytiscus* and *Hydrophilus*. On investigation it was found that while the hard chitinous surface layers were preserved and exhibited these original colours the structure beneath them was more or less disintegrated and destroyed.

The vast majority of the remains were those of beetles, in some cases almost intact, but much more often more or less broken with the parts dispersed. From a large quantity of material the following have been selected :—

COLEOPTERA.

Cicindelidae.

Megacephala sp. (prope *viridis*). About twenty individuals; usually consisting of elytra and abdomen; in a few cases the thorax and even the head are present as well. Some are quite black, others show distinct iridescent colours on both elytra and underside. The species was rather smaller than *viridis*, with, in good specimens, a more lively play of colours, the base being purple, changing to fiery red and coppery at the humeral angle; posteriorly it changed to dark green and then black over the posterior half. *M. affinis*, Dej., now existing in Trinidad is much more coarsely punctured.

Carabidae.

Calosoma glabratus, Dej. Three individuals, one with head and thorax present, agree well with modern specimens from Colombia. There are no specimens from Trinidad in the British Museum.

Calosoma sp. (prope *curvipes*, Kby.). Tip of one elytron.

Galerita moritzi, Mann. One pair of elytra agrees well with the very characteristic sculpture of this species. The British Museum series consists of material from Colombia, Venezuela and the Amazons.

Enceladus gigas, Bon. Five individuals consisting of pairs of elytra, in one case with the head and thorax. The genus contains but the one species and is represented in the British Museum by specimens from Colombia, Venezuela and Trinidad.

Chlaenius sp. Two individuals, both with head and thorax attached; in one of them the head and thorax are distinctly greenish metallic; the other is completely black. About the size of *C. herbaceus*, Chevr., but with different puncturation.

Pterostichus (?) sp. One individual.

Harpalus (?) sp. One individual.

Selenophorus sp. Allied to *S. multipunctatus*, Dej.

Dytiscidae.

Megadytes giganteus, Cast. About twenty specimens, represented by elytra and undersides. The olive-green colour of the elytra is sometimes more or less restored by washing with petrol, but no trace has been seen by me of the testaceous border (cf. Dr. Kugler's report, *Dytiscus*). The area occupied by this testaceous colour is almost always more or less broken and decomposed, while in some specimens the dark areas are also much decomposed, so that the species would be unrecognisable were it not for the better preserved examples. Some detached tibiae and tarsi exhibit the fringe of swimming hairs in excellent condition. Present range: Mexico, Guatemala, Yucatan, Cuba, San Domingo, Guadaloupe, Brazil (Bahia). None from Trinidad in the Brit. Mus. and the late Dr. C. L. Withycombe told me that, though the beetle is common in Venezuela, he had never seen it in Trinidad.

Megadytes fraternus, Sharp. About six specimens of a smaller species than the last, three of them exhibiting the characteristic sculpture of the ♀ of this species. Occurs from Mexico to Colombia, Venezuela and the Amazons (Santarem), Jamaica, San Domingo and Dominica. In the Brit. Mus. collection are also specimens from California and Chili. Professor J. S. Dunkerly has recently taken the species in Trinidad.

Rhantus calidus, F. (?). This is the insect most abundantly represented in the deposit. It is impossible to identify it positively with the existing widely distributed Tropical American species, not only on account of its uniformly black colour, but the chitin of the elytra even in the best-preserved specimens is more or less collapsed giving an uneven pustulose appearance. Frequently, the upper cuticle has disappeared altogether, leaving irregular umbilicate pustules which are quickly destroyed even by gentle brushing with a soft brush dipped in petrol.

Hydrophilidae.

Hydrophilus ater, F. and *H. insularis*, Cast. Five or six specimens of each species. They both differ from their present-day representatives in the strong development on the elytra of a row of fine granules or tubercles on each side of, and some little distance away from, the longitudinal rows of punctures. In some recent specimens the presence of such tubercles is indicated, though in most there is no sign of it. It is, however, possible that these tubercles are the ends of struts connecting the upper with the lower surface of the elytron and that owing to the partial collapse of the intermediate tissue and the approach of the two surfaces towards one another the ends of these struts now project a little above the general level.

Both species occur in Mexico and Central America, Venezuela and Trinidad, and the West Indies; while *H. ater* extends southwards over Brazil.

Tropisternus apicipalpis, Chevr. (?), and *T. nitens*, Cast. (?). About half a dozen specimens of each. These cannot be definitely identified with the recent species, but agree well with them in general form and size, and both

are now found in Venezuela or Trinidad. Many specimens show lines of fine tubercles corresponding to those mentioned under *Hydrophilus*.

Copridae.

Pinotus belus, Har. (?). A single pair of elytra agree well with recent specimens from Trinidad.

Melolonthidae.

A pair of elytra are doubtfully assignable to this family.

Dynastidae.

A single elytron probably belongs to this family.

Cetoniidae.

Gymnetis, sp. One specimen almost complete.

Trogidae.

Trox sonorae, Lec. (?). One elytron resembles this North and Central American species very closely, but is doubtfully identical.

Tenebrionidae.

Opatrinus, sp. Several specimens belonging to a species about 5 mm. in length resemble this genus in puncturation, but are not assignable to any species known to me. In some cases several individuals are collected into a small group.

Armalia, sp. One example consisting of head, thorax and elytra. A North and Central American type, though *A. chiriquensis*, Champ., is known from Colombia.

Buprestidae.

Acmaeodera xanthosticta, C. & G. A pair of elytra with thorax agree very well in sculpture with this species though there is no trace of the characteristic yellow spots.

Curculionidae.

A pair of rather crumpled elytra with a Barid type of sculpture.

Of the orders other than Coleoptera the following have been recognised :—

RHYNCHOTA.

Two fragments probably assignable to the family Pentatomidae.

ORTHOPTERA.

Three elytra of different sizes appear to be referable to *Typophyllum*. The leaf-like elytra are entire, lacking the emarginations simulating the ravages of caterpillars characteristic of many species of this genus.

HYMENOPTERA.

A pair of fore-wings with the thorax; very imperfect but probably a bee, Colletidae; wing length about 10 mm.

LEPIDOPTERA.

One fore-wing and one hind-wing of a Limacodid allied to *Limacodes*.

Most commonly the specimens occur singly, but in some cases a small group are found all close together. Sometimes these groups are composed entirely of members of one species, though sometimes their contents are much more varied. One such group exhibits, all on a surface of $2\frac{1}{2}$ in. $\times$ 3 in., the following species :—*Calosoma glabratus*, *Chlaenius* sp., *Pterostichus* sp., *Megadytes giganteus*, *Hydrophilus insularis*, *Rhantus* sp., *Dynastid* (?), *Gymnetis* sp., and a small Tenebrionid, as well as other fragments not even thus far determined.

The state of preservation of the material varies considerably ; this variation being, to some extent at least, dependent upon the species ; thus the hard thick elytra of *Hydrophilus* are usually in a better state of preservation than the more thinly armoured *Megadytes*, and in these the part that in life is testaceous is almost always destroyed, while the dark area remains. The elytra of this species show on their upper surface a number of feeble and indistinct pores. In most of the specimens examined the inner and under portions of the elytra, being less strongly chitinised, are more or less broken away. In those in which decomposition is less far advanced each of the punctures, from the outside scarcely visible, is continued as a central rod, evidently a hard strut connecting the strongly chitinised dorsal surface with the much more feebly chitinised lower surface, surrounded by a mass of black material. In the more decomposed specimens this material is much reduced or has disappeared, and eventually even the central rod disappears, leaving the pores, represented by low conical prominences, much more evident than the corresponding depressions on the upper surface.

Occasionally the strong upper cuticle has gone, probably having been peeled off in extracting the specimen from its matrix. The upper end of the central core then forms the centre of a round smooth disc of the medullary material, and with a lens the elytron appears as if composed of a number of densely crowded umbilicate tubercles, these tubercles separated by an irregular reticulate series of cracks. This structure, as may be supposed, is extremely delicate, and will not stand cleaning with even the softest brush. This condition in the remains of *Rhantus* is very much more frequently found than in those of *Megadytes*. In *Hydrophilus* the structure is very different, the punctures being limited to widely separated striae.

From the above list of species identified it is apparent that the great majority of the remains preserved are those of aquatic beetles, Dytiscidae and Hydrophilidae. Next in order of numbers come the Geodephaga, ground-dwelling beetles, some at least of which, *e.g.* the *Megacephala*, probably haunted the bare earthen margins of the pond, and were quickly engulfed in the same disaster that overtook the water-beetles. Of the rest, except for the *Opatrinus*, another ground-dwelling species, most of the insects are represented in the material examined by single specimens, whose presence is probably to be accounted for by their having been washed down with flood water. It is to be noted that many of these are also ground-dwelling species.

It is further evident that a large proportion of the species are recognisable as still extant in Trinidad, or at any rate so little different from the present fauna that in the fragmentary remains before us the differences are not apparent. Probably, indeed, were the present fauna more adequately known the proportion of existing species among these remains would be found to be still higher. We can therefore conclude that the conditions under which they lived were not very different from those obtaining at the present day, and that the insect fauna of the region was nearly if not quite the same as that now existing.

Without being able to say how far back into the past such conditions have remained practically constant, we may suppose that climatic conditions at least have remained much more stationary in the tropics than they have in central and northern Europe ; and here, though there is evidence that the distribution of certain species has altered since glacial times, there has been but little alteration in structural specific characters.

So far therefore as the entomological evidence goes it is quite in accordance with the conclusions arrived at by Dr. Kugler on stratigraphical grounds, viz. that " these fossil-bearing sands are perhaps Upper Pliocene, perhaps Quaternary, or probably Sub-recent."

Report on a Fossil Locality for Arthropods and Vertebrates in Trinidad (B.W.I.)

By H. G. Kugler.

During a geological investigation of the holdings of the Apex (Trinidad) Oilfields, Ltd., near Fyzabad, the writer discovered (1922) in a test-pit saturated oil sand which contained a remarkable number of arthropods and vertebrates. The writer is indebted to Col. H. C. B. Hickling, the manager of the Company, for having allowed him to secure a large amount of material for scientific investigation.

Topographical and geological position of the fossil-bearing beds and their nature.—The oil sands under review are situated about $\frac{3}{4}$ mile south of the Fyzabad Junction village and about 300 ft. west of the main road leading to the Fyzabad Oilfield. The road runs in this part of the country through an alluvial plain about a $\frac{1}{4}$ mile broad, which was caused by fairly recent submergence of the valleys of the last erosion cycle. The alluvial plain is not more than 35 ft. above sea-level, being an extension of the large Oropuche Lagoon, and is drained by a small ravine with tributary gulleys coming from the low hills. The oil sand is outcropping at the junction of a narrow alluvial infilling of such a little gulley and the Tertiary beds which form the low hills of the country. Further, they are situated to the immediate north of the crest of a westerly plunging anticline. The outcropping Tertiary beds consist of well-bedded sandy clays with oil sand lenses of probably Upper Miocene age. As the fossil-bearing oil sands are nearly imbedded like some of the Tertiary ones, it was difficult to judge in the first instance whether these oil sands are interbedded in the fairly steeply inclining Tertiary beds, or whether they belong to unconformable covering younger beds. Closer examination has shown, however, that the sands are lying probably horizontally, and that they show the following succession of beds from top to bottom :—

(*a*) 4 ft. of yellow sand, a little clayey and of a recent aspect.
(*b*) $\frac{1}{2}$ ft. of hardpan, consisting of tough sandstone, secondarily cemented by descending solutions of silica and ironoxides.
(*c*) $\frac{1}{2}$ ft. of brown-black highly saturated oil sand with few Coleoptera in the lower part.
(*d*) 1 ft. black sand highly saturated with heavy dark-brown oil and loaded with arthropods, especially Coleoptera, and few remains of vertebrates, especially mice. Thin streaks and patches of dark clay soaked with oil are interbedded, and these are an ideal matrix for interment of the finest parts of beetles as, *e.g.*, the flat paddling foot of a *Dytiscus* complete in every detail.

No deeper excavation has taken place up to the present, but from other places near by it can be expected that the oil sands are persisting to a greater depth, as augur drilling has proved that they are still to be found up to 25 ft. with interbedded dark clay layers.

Preservation of the fossils.—In the upper sand stratum (*c*) the beetles are mostly carbonised and scarcely any bone remains found. In the highly saturated deeper sand layers there are abundant arthropods in a magnificent state of preservation. Very common are CARABIDAE and HYDROPHILIDAE as well as DYTISCIDAE. Numerous are minute beetles, ants, here and there a wasp or a dragonfly, while even a moth was observed, and surely many more orders of arthropods can be found by a more detailed examination.

The beetles of the drier sands are all black. When excavations were commenced in the highly saturated sands and clays a large *Dytiscus* was found which showed olive-green and brownish colours in the wing-covers, emerald-green head and thorax and similarly coloured margins to the wing-covers. After about half an hour these colours had disappeared and the beetle assumed a pitch-black colour. The writer thought that the beautiful iridescence had been caused by thin oil films, which when evaporated in the open air caused the changing of colours. When, however, more DYTISCIDAE appeared with green colours associated with pitch-black HYDROPHILIDAE and CARABIDAE of the most beautiful metallic colours ranging from peacock-blue to green, gold and bronze or a fly with its fat, bright steel-blue abdomen, and all these different colours turned to black after half an hour's exposure, the idea of an oil-film coating had to be abandoned. The beetles are actually partly preserved in the full beauty of their natural colours, which may be preserved only by preventing oxidation of the highly sensitive tints. The writer put the beetles in gasoline as soon as they had been freed of oil sand and could in this way stop this rapid oxidation, but after several days he observed that the colours gradually faded; perhaps daylight is alone sufficient to kill the colours. The skulls and other bones of mice found, as well as those of a bird of the size of a crow, are partly well preserved although brittle and completely black.

Probable conditions during the deposition of the fossil-bearing sands.—The depositional conditions under which these arthropods and vertebrates have been imbedded are somewhat vague. That a seepage in land of heavy oil had trapped the insects was impossible, as nearly all the beetles are found with elytra closed, which would not have been the case if they had stuck flying in the sticky, heavy oil. The large numbers of HYDROPHILIDAE and DYTISCIDAE, as well as the dragon-flies, indicate a fresh-water swamp, and the commonly occurring remains of mice prove the presence of near-by *terra firma*. The deposition of sand with oil must have occurred fairly rapidly, as the beetles are mostly complete and so are most of the mouse skeletons. It seems likely that a ravine during times of flood brought down sand and fairly fresh oil into a pond, killing the water-beetles, and bringing down at the same time mice, etc., which had been drowned. Large pieces of semi-carbonised wood also are to be found.

Age of the deposits.—The fine state of preservation of the fossils argues against the inclusion of these sands in the Upper Miocene strata, as they would have been considerably altered if they had had to withstand the pressure of the overlying 2,000 ft. of sands and clays which are known to exist above the beds which are outcropping near the oil sands. The horizontality of the beds is another point in favour of placing their time of deposition subsequent to the last folding movement.

The fossil-bearing sands are perhaps Upper Pliocene, perhaps Quaternary or probably Sub-recent.

ON THE BRUSH ORGANS IN THE NOCTUID MOTH *LAPHYGMA FRUGIPERDA*, SM. & AB.

By H. Eltringham, M.A., D.Sc., F.Z.S.

[Read March 2nd, 1927.]

Plate XIII.

During last summer (1926) my friend the late Dr. C. L. Withycombe kindly sent me a male of the small Noctuid moth *Laphygma frugiperda*, which he had taken in Trinidad. The moth was attracted to light, and while fluttering on a table he had noticed what seemed to be brushes protruding from the extremity of the abdomen. Thinking that the structure of these might prove an interesting study, he placed the moth in a suitable preservative and forwarded it to me for further examination. Commander J. J. Walker at once identified the moth, which is a common S. American species, and his diagnosis was confirmed by Mr. W. H. T. Tams of the Natural History Museum.

Investigation of the anatomy and histology of a species by means of a single example is necessarily somewhat unsatisfactory, as it frequently proves desirable to cut sections in greater number and in more directions than the limited material will allow. Although there should not be any great difficulty in obtaining a further supply of so common a moth, the organs revealed by examination of this one example seem of sufficient interest to warrant the publication of the present account. A further supply of specimens may serve to increase our knowledge of certain details not at present worked out.

A superficial examination shows that the abdominal organs observed by Dr. Withycombe were not the only peculiarities of the species. On each femur of the anterior pair of legs there is a large fan-like brush, which is carried, when not in use, in a pocket-like fold on the ventral side of the thorax. These folds are formed by a mass of curved scales of considerable length and of very irregular section. Fig. 1, Plate XIII, shows the head and thorax of the moth viewed from beneath, after removal of the appendages and most of the cuticular scales. At *p* is the right pocket or fold, the median area between the two pockets being protected by a kind of rosette of darker stronger hairs. When examined under a low power of the stereoscopic binocular, there appears to be a layer or fold of exceedingly thin and delicate membrane overlying the scales and holding them together. This membrane is so thin that it has the typical iridescent colours often seen in such structures, and it seems to be destroyed or washed away in the process of section-cutting. Fig. 2 is a more highly magnified view of the femur of one of the anterior legs with the brush which arises therefrom. Sections of the femur do not reveal any glandular structures in connection with the brush, so that one may regard this organ as distributive in function. One would expect the glandular apparatus, if any, to be found in the thorax, in connection with the fold of special scales; and by removing the external layers of the thorax in this area, and cutting a series of transverse sections, a small glandular structure was found. Fig. 6 is a drawing of such a section. At sc_2 are sections of two of the curiously irregular scales which form the pocket. sc_1 is a scale arising from its socket, *ct* the cuticle of the thorax, beneath which are the gland-cells, one being marked *gc*. These cells are of a type which I have not so far observed in any of these lepidopterous

scent organs. In section they are seen to form a very irregular pattern. The outer part consists of a thin granular layer, in which a nucleus, *n*, is sometimes visible. The granular layer is lined with a stratum which in section presents lines of small highly refractive bodies *rb*, and this layer is in turn lined with a very delicate almost colourless mass *m*, presenting faint radial striation. This striated layer does not fill the whole cell but leaves a space sometimes proportionately large, and sometimes extremely small. Occasionally, as at sc_1, a scale-stalk appears to lead directly into one of the gland-cells, though the direct connection of scales and gland-cells is not in any case so obvious and complete as, for instance, in the abdominal glands of *Eryphanis polyxena*, described in our *Transactions* for 1926, p. 367. Moreover, the gland is not of the columnar type found in that species, and whilst all the cells doubtless contribute to the supply of the secretion, there must be many which do not communicate directly with scales. It seems evident that we have in this species a scent-apparatus resembling in its general arrangement that found in such species as *Phlogophora meticulosa*, *Xylophasia monoglypha*, and other Noctuid moths (see *Trans. Ent. Soc.*, 1925, p. 1), and also in *Hepialus hectus* (see Deegener, *Zeit. Wiss. Zool.*, 1902, p. 276). In *hectus* there is a wide expansion of the tibia of the third pair of legs which, according to Deegener contains the glandular apparatus. The tibial expansion lies in a thoracic pocket as in *frugiperda*.

In *meticulosa* and *monoglypha* the brushes arise from the first abdominal segment, and normally lie in folds of the abdominal cuticle, such folds being lined with special scales having glandular cells in communication with their sockets. As in *frugiperda*, the present species, the brushes are distributive and the glandular folds secretory.

If we now examine the distal extremity of the abdomen we find a new and very remarkable organ. At fig. 3 is a side view under a low power of the terminal abdominal appendages. *c* is the clasper, *r* the evaginated rectum, *u* the uncus. Arising from the proximal external surface of the clasper is a peculiar bladder-like process *bp*. One is reminded of the harpal appendages found in moths of the genus *Rhodogastria*, and described by Mr. Bethune-Baker in our *Transactions* for 1925, p. 321, although in these appendages there appears to be an elaborate apparatus for extension and withdrawal, whereas in *frugiperda*, so far as I can judge from the single example at my disposal, the organ is permanently distended. Externally it has the appearance of a thin membrane, clothed with long delicate spatulate scales. These arise from the greater part of the surface, though a careful examination shows that they are mainly assembled in the form of two pairs of principal masses forming together the four brushes as seen in the more highly magnified ventral view shown in fig. 4. In addition there are small tufts of stiffer hairs *sb*. One of the long spatulate scales is shown at fig. 5. These scales are cylindrical for a great part of their length, and then widened and flattened. Contrary to what might be expected the spatulate portion is thinner in the centre than at the edges, a transverse section having the appearance of a rod with a swelling at each end. The surface is very finely striated, and covered with very small projecting nodules. The scale shown in fig. 5 has an actual length of 2·4 mm.

The investigation of the internal structure of the bladder-like organ proved rather difficult in view of the paucity of material. The arrangement of tissues is complicated and a complete elucidation would require far more sections than I have been able to obtain. Moreover, the internal tissues are of such an unusual kind that an exhaustive study would require material preserved in a variety of fixatives, and stained by several methods. So far as I have been

able to follow it, however, the organ seems to consist of a membrane of variable thickness, the surface of which is thrown into a complicated series of folds and modified into scale-sockets. Where the membrane is comparatively thick it appears as at *c*, fig. 7, and the scales, *sc*, are inserted in the sockets in the usual way. The inner extremity of each scale is slightly widened so as to form a kind of funnel, and there extends from it, or enters into it, according to the point of view, a thread or process, *s*, communicating with a reticular mass of cellular substance *rt*, lying beneath, but not for the most part contiguous to, the cuticle or membrane. Beneath this cellular layer is a very fine and apparently fibrous reticulum *irt*, which, towards the anterior end of the organ, seems to fill all the rest of the cavity, but posteriorly is less continuous. A very remarkable feature is the wide variation in the size and relative positions of these structures. At fig. 8 is a view of the same parts in another position, and here the threads or processes joining the scale-sockets to the cell-substance are much longer and thicker than in fig. 7, whilst the membrane and the cell-layer are thinner. The cell-layer consists of a granular mass containing many almost circular bodies which look like vacuoles containing granules. Nuclei cannot be made out with confidence, though in some sections small bodies taking a somewhat darker stain may perhaps be thus interpreted. Finally there are found, scattered promiscuously over the section, sometimes in the cell-layer, sometimes in the communicating processes, or even loose in the intervening space, large heavily staining bodies, *d*, the nature of which I am unable at present to determine. In fig. 8 one of these bodies, *d*, is seen at the distal end of a process, whilst at *t* a similar process appears burst, as though it had also contained one, afterwards torn out in the operation of section-cutting. There seems generally, though not quite invariably, to be at least one of these dark bodies associated with each process leading from the cell-layer to the scale-socket. In some sections they are elongated instead of rounded.

As most coagulated secretions take a deep stain in insect-gland preparations, we might suppose that we have in this case particles of some coagulum produced by the secretion of the cell-layer. At present, however, the glandular nature of this harpal organ is not fully established. In cases where scales are in direct connection with gland-cells we generally find granules of the secretion in the scales, as for example in the stained bodies in the transverse sections of the thoracic scales of the present species, sc_2, fig. 6. (See also the scales of the abdominal gland in *Eryphanis polyxena*, *Trans. Ent. Soc.*, 1926, Plate LXXXIV, fig. 5.) One of the peculiarities of the scales arising from the harpal organ in *frugiperda* is the absence of any appearance which would suggest the existence of a secretion.

I have thought it better to publish descriptions of these organs without waiting for further material, in the hope that naturalists who have the opportunity may be induced to study the moth in its natural surroundings. They may then be enabled to investigate the behaviour of the insect and perhaps attempt to discover the function of this organ.

An examination of any large collection of moths shows that brush-organs in great variety of form and position are present in many species. When our collectors realise that a few examples of such insects, preserved in suitable media, are of more interest than whole series of dried specimens in papers, we shall be better able to make an exhaustive study of these and the many other organs of which we know so little. For the assistance of those abroad who may possibly read this paper I may repeat that examples placed for a few hours

in a saturated solution of bichloride of mercury in water, to which is added an equal bulk of ordinary spirit, are usually quite satisfactory for microscopic examination. After "pickling" in the above solution they should be placed in small tubes or bottles with ordinary spirit (about 95%), and will travel well by post. In the absence of this salt of mercury, fairly good preparations may even sometimes be obtained from material which has been plunged for a few moments into boiling water and then preserved in about 95% spirit.

Explanation of Plate XIII.

Fig. 1. Enlarged view of the underside of the thorax of *Laphygma frugiperda*. The appendages and most of the cuticular scales have been removed. *p* the pocket or fold in which the femoral brushes lie when not in use.

2. The femur and part of the tibia, more magnified, showing the fan-like brush expanded.
3. Distal extremity of abdomen. *u* uncus, *r* evaginated rectum, *c* clasper, *bp* bladder-like process.
4. Ventral view of same, more highly magnified. *c* clasper, *bp* process, *sb* small stiff brush.
5. One of the scales forming the brushes on the harpal organ. The actual length of this scale is 2·4 mm.
6. Section through thoracic cuticle beneath the pocket in which the femoral brush lies. sc_2 sections of the scales forming the pocket. The dark granules are probably the secretion of the gland-cells. *ct* the cuticle, sc_1 part of a scale, *gc* a glandular cell, *n* nucleus, *rb* the layer of refractive bodies, *m* the transparent radiated layer.
7. Section through a portion of the bladder-like process or harpal organ. *c* the cuticle, *sc* part of a scale, *d* one of the darkly staining bodies, *rt* the cell-layer, *s* one of the processes communicating with the scale-socket, *irt* the inner reticulum.
8. Section through two of the communicating processes in another part of the harpal organ. *rt* the cell-layer, *s* one of the communicating processes, *d* one of the darkly staining bodies, *sc* a scale-stalk, *t* outer part of one of the processes apparently torn open.

(Stalk or process *s* in Fig. 8 is ·06 mm. long.
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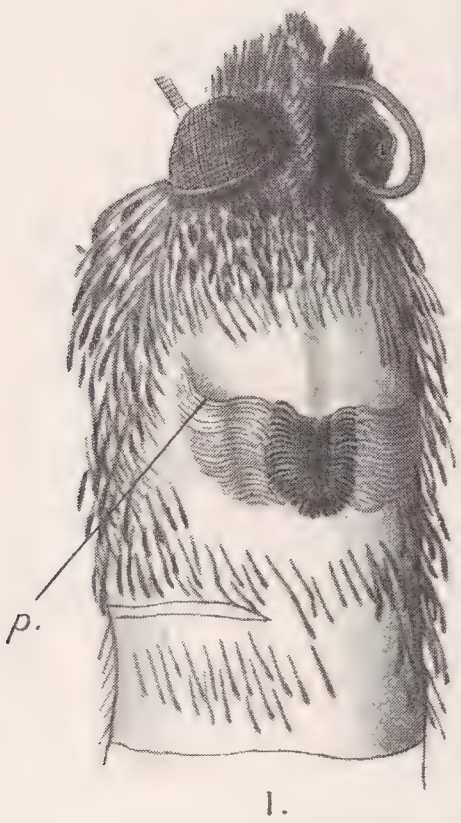

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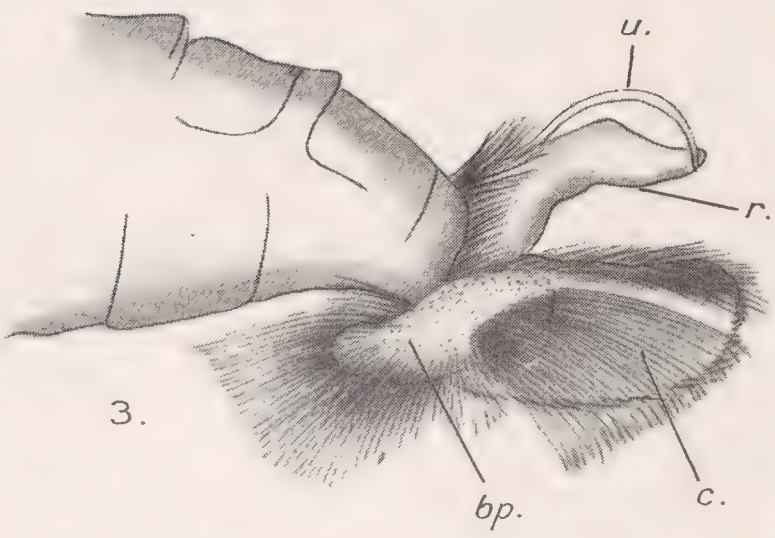

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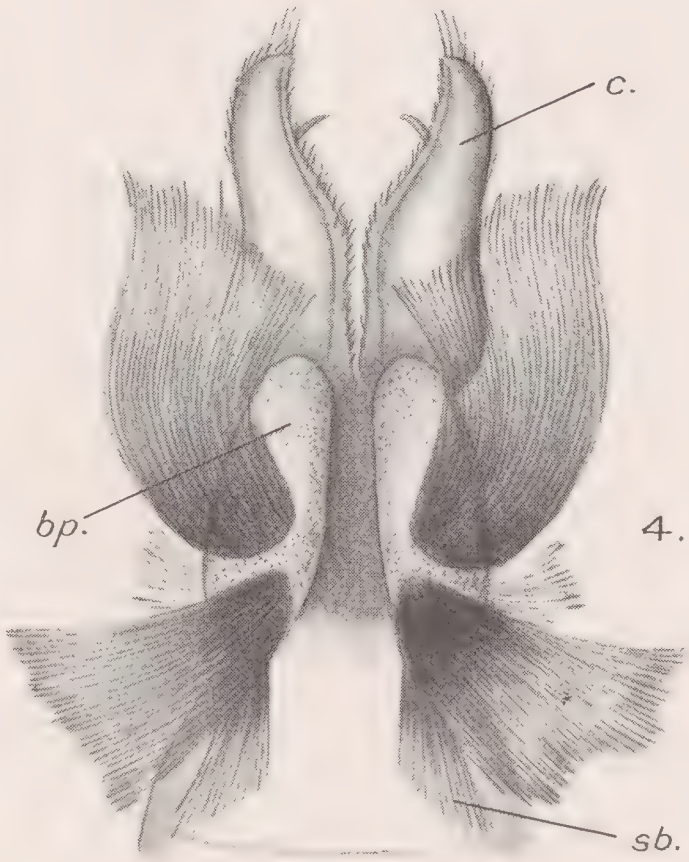

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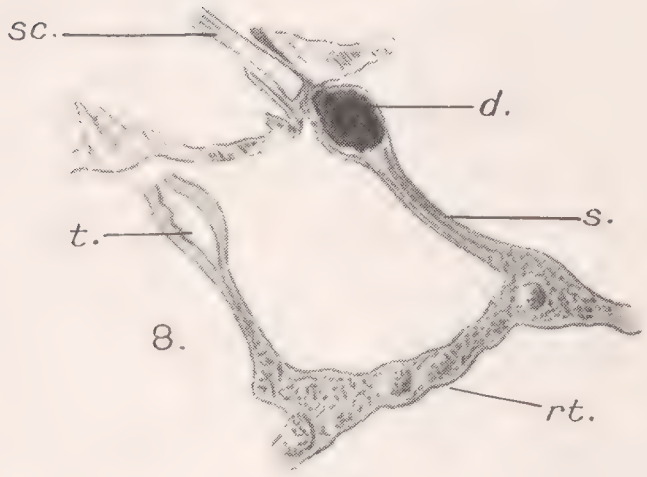

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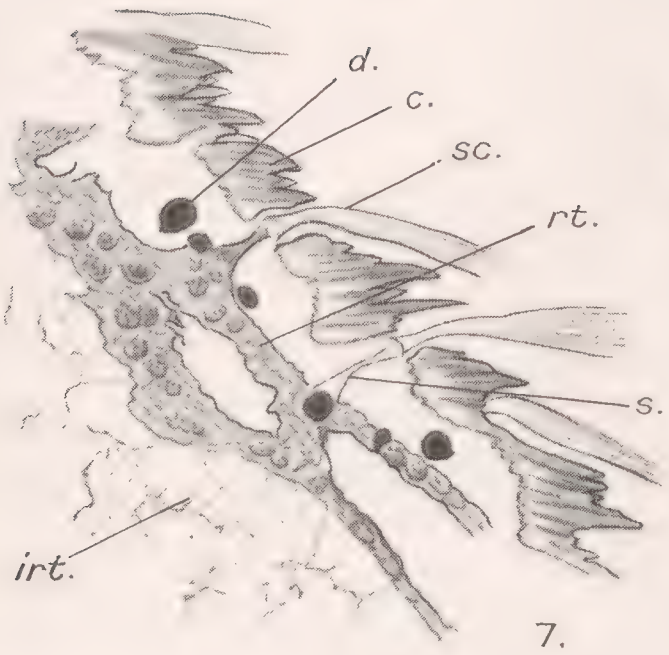

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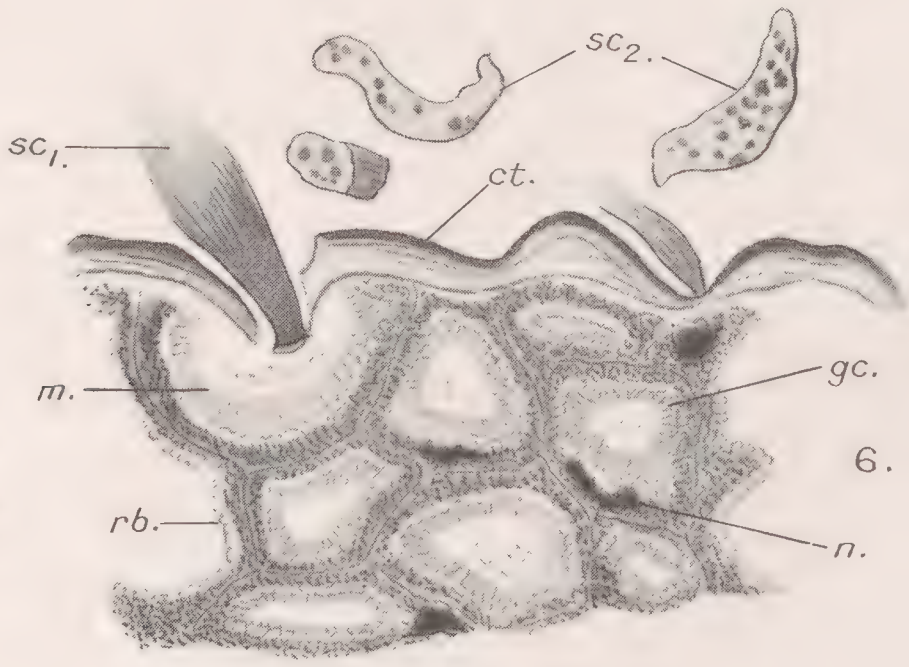

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H. Eltringham, del.

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THE BRUSH ORGANS IN THE NOCTUID MOTH
LAPHYGMA FRUGIPERDA, Sm. & Ab.

A CONTRIBUTION TOWARDS THE INSECT FAUNA OF FRENCH OCEANIA

Part I.

By L. Evelyn Cheesman, F.Z.S.

[Read April 6th, 1927.]

Plates XIV–XVI.

In 1924 I accompanied the St. George Expedition (inaugurated by the Scientific Expeditionary Research Association) to the South Seas. Among the groups of islands of the South-east Pacific visited by the expedition were :—

(1) The Marquesas Islands, where about five weeks were spent upon four islands—Hiva-oa, Tahuata, Fatu-hiva and Nuku-hiva.

(2) The Tuamotus or Low Archipelago, upon which group one day was spent upon Napuka and five days upon Faka-rava.

Collecting was carried out by daily expeditions from the yacht.

I left the expedition at Tahiti and spent five months on—

(3) The Society Islands, working upon three islands—Tahiti, Raiatea and Bora Bora.

While engaged in working out the material collected on these three groups of islands—the Marquesas, the Tuamotus and the Society Islands—it appeared advisable to include earlier records in the list wherever possible, as there is no comprehensive work upon the insect fauna of this part of the Pacific. The cultivators on these islands are in urgent need of such a work, for they cannot make use of the literature which is extant dealing with the economic species.

Early records are surprisingly scanty, nor are they always reliable. For instance, in several of Stål's records of insects collected from Tahiti during the voyage of the *Eugenie* in 1857, the locality was given in error, probably due to the incorrect labelling of the specimens. Original descriptions are also in many cases unsatisfactory : the work of early authors being characterised by extreme diffidence in committing their impressions to paper, one is left in doubt when confronted by the multitude of species which have come to our knowledge since their day as to which species they were describing. There are also errors in classification which can be rectified only by specialists working upon those particular groups with more material than is at present available.

THE MARQUESAS ISLANDS.

These are a group of volcanic islands situated between lat. 7° 50′ and 10° 35′ S. and long. 138° 25′ and 140° 50′ W., the largest, Hiva-oa, being 25 miles long and 8 miles wide. The highest point is Mt. Poutetainui on Ua-pou (4040 ft.). There are scarcely any level stretches of shore; but, with the exception of the river mouths, the coasts being unprotected by coral reefs are cut off abruptly as high, rugged, bare cliffs, scored by waterfalls which are flung off them into the sea from tremendous heights, and with their bases exposed to the action of heavy rollers. Near the coast the scrub is dense, except where it has been burnt back from cultivated areas. The central regions are elevated, scrub-covered plains, cut into deeply by densely-wooded

valleys: with occasional stretches of open country—marked "plateau" on French charts—which present a remarkable contrast, being covered only with coarse grass, small patches of low scrub and groups of *Pandanus*. On the west of Nuku-hiva is a very extensive region of this type of highlands 1500 to 2000 ft. above sea-level—marked "le desert" on French charts—with belts of *Casuarina* and of scrub. This interesting region is reached by climbing an almost perpendicular 1600 ft. cliff at the western horn of Hakaui bay.

Guava has been introduced upon all those islands visited by the expedition: it has spread into the interior where it is said to be ousting the indigenous vegetation. A few good trails cross the islands at various points. The majority of the valleys are planted up with coconut-palms and are partly under cultivation; and cattle, ponies and goats in a semi-wild condition graze on the rough land of the interior.

All villages are situated on the coast near river mouths; these are thinly populated. Handy in 1923 recorded 1800 inhabitants on the entire group, as opposed to 50,000 in the year 1850.

The temperature scarcely varies throughout the year; the mercury seldom rises above 90° or drops below 70° F. The South-east Trades blow from April to October with a general direction of E. to S.S.E., and as the rain-laden winds expend the greater part of their moisture upon the eastern districts of the islands, vegetation is more luxuriant on the windward sides. Rainy and dry seasons are not distinctly defined, and the annual rainfall is very irregular; there are years of abnormal rainfall and there may be several years of drought.

The most interesting species of insects taken occurred in the central regions toward the windward side of the islands; the greatest variety of species as well as the greatest number of individuals were taken in the valleys. But, as might be expected, the majority of species collected in the cultivated areas belong to widely distributed genera. The conditions generally were dry on all four islands.

THE TUAMOTUS OR LOW ISLANDS.

(Ancient name Poumotu corrupted by Europeans into Paumotu).

In marked contrast to the mountainous islands of the Marquesas group are the coral atolls of the Low Archipelago, which extend almost 700 miles from N.W. to S.E. (lat. 14° and 20° S. and long. 138° and 149° E.). Two atolls were visited by the expedition: Napuka, which is isolated with Tepoto to the north-east, and Faka-rava, the largest of the group, the lagoon of which is thirty-two miles long and ten miles wide.

There is a considerable variety of species of vegetation of the usual madreporic type, forming a belt on the centre of the islets encircling the lagoon. Coconut-palms (the main support of the inhabitants), *Pandanus*, *Thespesia*, *Barringtonia*, *Calophyllum* and other coral dwellers attain a fair height.

Belts of low scrub among the trees are so dense that although the reefs are nowhere very wide—the average width being about 150 yards from the ocean to the lagoon—it sometimes required an hour's work to force a way through such belts. On Faka-rava were occasional open areas in the scrub, covered with tufts of *Juncus* and a coarse grass, where once or twice I found a superficial layer of humus—which may have been imported—elsewhere the surface consisted of broken coral, limestone rock and fine, grey coral sand several inches in depth. There were ponds on Faka-rava, but upon Napuka I saw only one well in the coral, containing then three inches of rain-water.

With the exception of ants, insects were not individually numerous, but,

considering the lack of attractions for colonisation, there was an unexpected number of species. Indeed the variety of life which is supported upon these hot, arid, inhospitable atolls is surprising. Jassids, a Tettigonid, a *Myrmeleon*, *Sceliphron*, *Pison*, *Odynerus*, and *Polistes*, several species of Diptera, were among the scrub. Four species of dragonflies were seen, one species of butterfly and several moths; blattids, earwigs, beetles, isopods, skinks and one species of gecko. Earth-worms and a slug were among fallen leaves, in tree-holes, etc., three species of land-snails among roots and under stones.

THE SOCIETY ISLANDS.

These form a group of high, volcanic islands, lying between 16° and 18° S. and 148° and 155° E. This group consists of 14 islands, separated by the French into " les Îles du Vent " and " les Îles sous le Vent."

Tahiti is the largest island of the group, over 130 miles in circumference, and 26 miles wide. The entire central region is occupied by the old crater, which to-day consists of irregular masses of high mountains (the highest, Mt. Orohena, 7349 ft.) and very deep valleys. A wide alluvial belt extends for the whole circumference except on the north-east of the Taiarapu peninsula, where the barrier reef is absent and the sea washes the base of high cliffs : a fairly good road serves this belt, interrupted in some districts by unbridged rivers.

The island is covered from the coast hills to the tops of the mountains with very dense, high scrub; there are scarcely any trails beyond the shore belt and lower parts of the valley, these being the only inhabited and cultivated areas.

Wet and dry seasons are not distinctly defined, but weather conditions generally are rainy; the climate although extremely moist is not unhealthy; the temperature is equable. In the so-called dry (or cool) season there are periods of fair weather, but it is unusual for these to be of more than a fortnight's duration. As on the Marquesas Islands, the eastern districts receive the greater part of the moisture and are considerably cooler. Nadeaud in 1873 recorded that certain species of plants which require cool and moist conditions are found 500 ft. above sea-level on the east, whereas the same species do not grow below 4000 ft. on the north and west. I found that this also applied to some species of insects, though not to the same degree.

The greatest variety of species of insects was taken in the valleys, and from 500 ft. to 2000 ft. above sea-level; above this altitude insects of all orders were surprisingly scarce—even the ants were absent. By cutting trails along the ridges of the coast hills and from the heads of valleys, I was able to establish collecting centres at distances of from 3 to 8 miles inland.

Raiatea belongs to the north-west group of the Society Islands. It consists of two distinct ranges of hills east and west almost severed by a wide bay. The highest point is 3389 ft.; the central regions are covered with scrub, which is less high and dense than that of Tahiti. On the north the coral reef also encircles the island of Tahaa, which results in extensive mud-flats on the northern coast of Raiatea, where there are considerable areas of marshy ground covered with indigenous vegetation offering new conditions for collecting.

Bora Bora, a small island lying 20 miles to the north-west of Raiatea, consists of a high rock mass of striking appearance, 3200 ft. in height, rising abruptly from a low, narrow shore belt and extending north in a short ridge which ends in a small crater. The island is about 26 miles in circumference and about $1\frac{1}{2}$ miles in the widest part. It is completely encircled by a reef which has formed a chain of islets around the northern point.

The collection of insects from the Society Islands numbered about 470 species. Until the whole collection is worked out it is not possible to generalise upon the question of distribution. But, apart from the widely distributed forms, the species appear to show more affinity with those of Indo-Malaya than those of Australia, or even with the species recorded from other groups of Pacific islands. The number of species of Diptera taken preponderates over that of the other orders.

ORTHOPTERA.

The Orthoptera collected have not yet been fully worked out. The ACRIDIDAE, and some of the TETTIGONIIDAE and BLATTIDAE have been named by Dr. Uvarov, and the GRYLLIDAE have been sent to M. Lucien Chopard.

ACRIDIDAE.

Of the five species of ACRIDIDAE four are new, belonging to two new genera.

1. *Ootua antennata*, Uvarov, Ann. Mag. Nat. Hist., (9), xix, p. 558 (1927).

Nine specimens, ♂, ♀ and 7 larvae in five different stages of growth, taken on Hiva-oa, Marquesas Islands, Jan. 1925 (*St. George Exped.*). Taken at about 2200 ft. at the base of Mt. Ootua, on the elevated plain which occupies the eastern part of the island. All the specimens were on the same verdant patch among a group of young trees, *Paritium tiliaceum*. In the earlier stages this species shows striking coloration, the bright vermilion, yellows and greens being further accentuated by black markings made the young larvae extremely conspicuous, especially as these were in an open position in bright sunlight. In the next two stages they show intermediate forms of coloration: two specimens in the last instar were taken among low-growing herbage. The adult male was stridulating on the branch of a tree, and the female was beaten out of foliage on the opposite side.

The antennae of both sexes are very long for this group, extending well beyond the pronotum.

2. *Valanga marquesana*, Uvarov, Ann. Mag. Nat. Hist. (9), xix, p. 562 (1927).

Taken on scrub-covered slopes above the Tai-pi Valley, Marquesas Islands, Jan. 1925 (*St. George Exped.*).

3. *Hydrotetrix cheesmanae*, Uvarov, Annals Mag. Nat. Hist., Ser. 9, vol. xvii, p. 654 (1926).

One (female) taken swimming in Lake Vaihiria, Tahiti, July 1925 (*L.E.C.*).

4. *H. aspera*, Uvarov, *loc. cit.*, p. 656.

A larva taken swimming in Darling's pool, on the hills above Papeete; a female, reddish-brown in colour, under a stone upon a slope of reddish-brown soil, and a female swimming in a stream at about 3000 ft., N. Tahiti, March 1925. One male from Hitiaa, Tahiti, swimming in the river about two miles inland, July 1925 (*L.E.C.*).

These small, apterous Acridids are most numerous at the heads of the streams, on the banks and among rocks. They are frequently seen swimming, but have no special structure to adapt them for an aquatic existence. The

first specimen taken was swimming in a deep pool in a rather dry locality on the coast hills. The specimen from Lake Vaihiria, *H. cheesmanae*, was also swimming in deep water. I was wading near the border of the lake catching Notonectids and saw a small insect swimming slowly from the direction of the middle of the lake towards the shore; it swam to a rock and remained clinging below the surface of the water. At the first attempt to take it, it leaped back out of the net into deep water and again struck out for the shore, where I secured it. These insects swim with slow strokes not far below the surface, and appear to avoid swift currents, unless disturbed, when they will leap into mid-stream. In order to leave the water they swim to a bank or rock, and climb out clinging to the solid surface. They are extremely active outside the water, leaping from boulder to boulder and slipping down between them if disturbed.

5. *Tetriginae* sp.

One specimen taken on Hiva-oa, Marquesas Islands, under a stone on a river bank, Jan. 1925 (*St. George Exped.*).

TETTIGONIDAE.

6. *Euconocephalus australis*, Bol., Artrop. Viaje Pacif., p. 90 (1884).

One specimen taken on Hiva-oa, Marquesas Islands, at 1000 ft., Jan. 1925 (*St. George Exped.*). Taken on all three islands of the Society group, March–August 1925 (*L.E.C.*).

This large green grasshopper, known as the Vi-vi by the Tahitians, occurs everywhere on the islands where the underbrush is not dense. It is found on the coast on low-growing plants among the coconut-palms, in the sugar-cane fields of Tahiti, in the valleys, on the hills wherever they are free from high scrub, etc. Both sexes were taken on the borders of Lake Vaihiria. There is a pale brown form which was present on Hiva-oa, one immature specimen of the same form was taken on Raiatea, and it was very numerous in all stages on one particular zone of grass above Fanui, Bora Bora.

Karny (Gen. Ins., Fas. 139, p. 35, Taf. 6, fig. 21, 1912) has synonymised this species with *E. extensor*, Walker, from an unknown locality. The form of the fastigium is, however, quite distinct in the two species, that in *E. extensor* being narrower and more acute at the apex than that in *E. australis*.

7. *Conocephalus* (*Xiphidium*) *affinis*, Redtenbacher, Verh. zool.-bot. Ges. Wien, xli, p. 380 (1891).

Taken on Raiatea and Bora Bora, June–July 1925 (*L.E.C.*). On the shore-belt among low-growing plants, and fairly numerous on grassy slopes of the coast hills to about 1500 ft.

8. *Xiphidium* sp.

One from Hiva-oa, one from Fatu-hiva, one from Nuku-hiva, Marquesas Islands, Jan. 1925 (*St. George Exped.*).

9. *Xiphidiopsis* sp.

Six specimens from the northern coast hills above Papeete, Tahiti; one specimen from Raiatea among short scrub at sea-level, 22.v.25 (*L.E.C.*).

10. *Phisis pectinata*, Guér., Voy. Coquille Ins., p. 150 (1830).

Taken on Napuka, Tuamotus, Feb. 1925 (*St. George Exped.*). Taken on the coast belt and coast hills of Tahiti, Raiatea and Bora Bora, March–August 1925 (*L.E.C.*). Flies actively, numerous among foliage, and has a habit of concealing itself in the buds of *Paritium tiliaceum*, with only the long antennae visible. One specimen was feeding upon young aphids.

Gryllidae.

Field crickets are very numerous on all the islands visited belonging to the Marquesas and Society groups. They occur anywhere on the islands, in the moist localities beside water, or on the hot coast belt under stones, etc., and among the bracken on the dry hills above Papeete. Upon one occasion when cutting a trail on a slope about three miles inland, through a thicket of tall plants (Compositae) whose stems grew very densely, as I opened up the ground to the sunlight, these crickets appeared in every stage of development in such large numbers that the whole surface seemed alive with them for several minutes, until they gradually disappeared again into the shade among the plants on either side of the trail.

Delicate, pale green crickets are to be found in numbers among the foliage of *Paritium tiliaceum* from the coast to high up the valleys; both sexes have the habit of concealing themselves in the buds of this tree, with the long antennae protruding. They are also to be found on the leaves of plants near water, especially on the broad-leaved peppers, and aroids, in deep ravines. In the same moist localities, often upon the same leaves, are small dark brown crickets, with dark longitudinal lines on the tegmina.

A small apterous cricket inhabits the littoral of these islands wherever the beach is sheltered from the waves, such as on the lagoon shores. A few specimens appear in the daytime, but at sundown they emerge from under rocks, etc., and sally forth in large parties consisting of adults and immature together, and feed upon the débris cast up on the coral beaches.

Blattidae.

11. *Blatella notulata*, Stål, Eugen. Resa. Ins., p. 308 (1859).

Numerous on all the islands. An extremely active grey species with a delicate colour pattern, which is found sitting openly on foliage in the sun, or concealed among dead leaves which collect between the fronds of tree-ferns, etc. It is preyed upon by *Tachysphex* sp. One specimen from Faka-rava, Tuamotus (*St. George Exped.*). Six specimens from Tahiti, one from Raiatea, two from Bora Bora, March–August 1925 (*L.E.C.*).

Previously recorded from Tahiti, *loc. cit.*

12. *Periplaneta australasiae*, F., Syst. Ent., p. 271 (1775).

Numerous all over the islands.
Cosmopolitan.

13. *P. americana*, L., Syst. Nat. (ed. 10), vol. i, p. 424 (1758).

Fairly numerous, especially near the coast.
Cosmopolitan.

14. *Diploptera dytiscoidea*, Serv., Ins. Orth., p. 102 (1839).

One specimen taken on Raiatea, June 1925 (*L.E.C.*), beaten out of bracken at 2000 ft.

15. *Pycnoscelus surinamensis*, L., Syst. Nat. (ed. 10), vol. i, p. 424, n. 3 (1758).

Both sexes taken on Faka-rava, Tuamotus, Feb. 1925 (*St. George Exped.*). Numerous among dead leaves collected in tree-holes.

Cosmopolitan.

Phasmidae.

16. *Graeffea cocophaga*, Newp., (*Alopus*) Phil. Trans., p. 288 (1844).

♂ ♀ (taken in cop.), 3 ♀, Tahiti, May 1925 (*L.E.C.*). Numerous throughout the Marquesas Islands and on Tahiti, Raiatea and Bora Bora.

My grateful thanks are due to Mr. Uvarov for kindly naming these species, and for his assistance and information.

ODONATA.

Aeschnidae.

1. *Anax gibbosulus*, Ramb., Hist. Nat. Neuropt., 1842.

♂ ♀ taken on Lake Vaihiria, Tahiti; larvae, probably of this species, taken near the margins of the lake, July 1925 (*L.E.C.*). Adults numerous on Faka-rava, Tuamotus, Feb. 1925.

Recorded from Australia, Queensland, New Caledonia, E. Indies, etc.

Libellulidae.

2. *Diplacodes bipunctata*, Brauer, (*Libellula*) zool.-bot. Ges. Wien., 15, p. 303 (1865).

Taken on Faka-rava, Tuamotus, Feb. 1925 (*St. George Exped.*). Numerous at sea-level Tahiti, Raiatea and Bora Bora, March–June 1925 (*L.E.C.*).

Recorded from Australia, Tahiti, Marquesas islands, and throughout the South Sea Islands.

3. *Tholymis tillarga*, F., Suppl. Ent. Syst., p. 285 (1798).

Taken in Papenoo, Tahiti, sea-level, March 1925 (*L.E.C.*).

Recorded from Tahiti, Brauer, zool.-bot. Ges. Wien, 14, p. 162 (1864).

4. *Pantala flavescens*, F., (*Libellula*), *loc. cit.*

Numerous on Tahiti, March 1925, Raiatea, June 1925 (*L.E.C.*).

Cosmopolitan. Recorded from Tahiti, Raiatea and Marquesas Is., Coll. Zool. Selys Longchamps, Fasc. xv, p. 919.

Zygoptera.

5. *Ischnura aurora*, Brauer, (*Agrion*) Reise Novara, p. 56 (1866).

Extremely numerous on the Marquesas Is., the Tuamotus, Tahiti, Raiatea and Bora Bora. In any moist locality from the coast to the centre of the islands.

Recorded from India, N. Africa, Australia and E. Indies, etc.

Other species previously recorded from Tahiti.

Anaciaeschna jaspidea, Bur., (*Aeschna*) Handb. Ent. Neuropt., 1839, vol. ii, p. 840. = *Aeschna tahitiensis*, Brauer, Reise Novara, p. 73 (1866).
Tahiti, Brauer, *loc. cit.*

Hemicordulia oceanica, Selys, Bull. Acad. Belge. (2), xxxi, p. 250 (1871). (Tahiti.)

My thanks are due to Mr. D. E. Kimmins for kindly determining these species.

HEMIPTERA HETEROPTERA.

Cydnidae.

1. *Geotomus pygmaeus* (Dall.), Signoret, Ann. Soc. Ent. France (6), iii, p. 51, pl. 3, fig. 160 (1883).

Tahiti and Raiatea, Society Is., 1925 (*L.E.C.*). Taken upon the leaves of *Tradescantia* on the banks of streams, and numerous at light from sea-level to 500 ft.

Widely distributed from India and Japan through the Malayan Sub-region to New Caledonia. Recorded from Fiji as common under cow-dung and at light. Recorded as being introduced into Hawaii in the soil attached to plants.

Pentatomidae.

Scutellerinae.

2. *Coleotichus sordidus*, Walker, Cat. Hem. Het., i., p. 1 (1867).

Eight specimens from Tahuata, Nuku-hiva, Hiva-oa, Marquesas Is., Jan. 1925 (*St. George Exped.*). Taken among low scrub and ferns, at 300 to 800 ft. and at light. One specimen from the Valley of Papenoo, Tahiti, upon foliage in sunshine, March 1925 (*L.E.C.*).

Previously recorded from—
I. of Pines, Walker, *loc. cit.*
Fiji, Stål. (*C. nigrovarius*), Enum. Het., p. 4 (1872).

Pentatominae.

3. *Glaucias sulcatus*, Montrouzier, Ann. S. Phys. Nat. Agric. Lyons (2), vol. vii, 1, p. 98 (1855).

Eight specimens taken on Tahuata and Hiva-oa, Marquesas Is., Jan. 1925 (*St. George Exped.*). At light and in low scrub, fairly numerous.

Previously recorded from—
Woodlark I., Mont., (*Pentatoma sulcatum*), *loc. cit.*
Lifu, Loyalty Is., Mont. et Sign., (*Rhaphigaster sulcatum*), Ann. Soc. Ent. France, p. 65 (1861).

4. *Plautia marcida*, Cheesman, Entomologist, vol. lx, 1927, p. 58.

Four specimens taken among grass and low herbage and at light, Faka-rava, Tuamotus (*St. George Exped.*), Feb. 1925.

5. *Piezodorus rubrofasciatus*, F., Mant. Ins., 2, p. 293 (1787).

Taken on Tahiti from sea-level to 2000 ft., Feb.–Aug. 1925. Raiatea, May 1925. Extremely numerous on both islands upon a leguminous plant (*?Cantharida* sp.). Has a habit of assembling openly on these plants, adults and immature together; the latter are variously and brightly coloured in the early stages.

Widely distributed throughout the Paleotropical Region.

Asopinae.

6. *Platynopus melacanthus*, Boisd., (*Pentatoma*) Voy. Astrolabe Ent., ii, p. 628, pl. 11, fig. 7 (1835).

One specimen from the Vaitepiha Valley, Tahiti, taken among foliage, 11.viii.1925. One specimen from Bora Bora taken at 500 ft. in the act of spearing an aphid, 19.vi.1925 (*L.E.C.*).

Previously recorded from—

New Guinea, Boisd., *loc. cit.*

Fiji, Guérin, (*Pentatoma falleni*) Voy. Coquille Zool., ii, p. 165, pl. 11 (1838).

Lifu, Loyalty Is., Mont., (*Heteropus melacanthum*) Ann. Soc. Ent. France, p. 61 (1861).

Tahiti, Mayr., Reise Novara Ins., p. 32 (1866).

Lifu Is., Vollenhoven, (*Canthecona apicalis*) Faun. Indo-neer., iii, p. 6, pl. 1, fig. 3 (1868).

Woodlark I., Vollenhoven, (*Canthecona biguttata*), *loc. cit.*, p. 8, pl. 1, fig. 6 (1868).

Solomon Is., Moluccas, Schouteden, Gen. Ins., p. 48 (1907).

7. *Oechalia consocialis*, Boisd., Voy. Astrolabe Ent., ii, p. 630, pl. 11 (1835).

One specimen taken among low herbage on Faka-rava, Tuamotus, Feb. 1925 (*St. George Exped.*). One specimen taken in scrub at 500 ft., Bora Bora, Society Is., 15.vi.25 (*L.E.C.*).

Also specimens in the B.M. Coll. from the Marquesas Islands collected by Commander Walker.

Previously recorded from—

W. Australia, Boisd., (*Pentatoma consociale*), *loc. cit.*

Australia, Guérin, (*Pentatoma schellembergii*) Voy. Coquille Zool., vol. ii, p. 166, pl. 11 (1838).

New Zealand, Walker, (*Raphigaster perfectus*) Cat. Hem. Het., vol. ii, p. 371 (1867).

New Zealand, Butler, (*Oechalia schellembergii*) Voy. Erebus and Terror. Zool., vol. ii, p. 25, pl. 7, fig. 2 (1874).

Tahiti, Kirk., Cat. Hem. Het., p. 381 (1909).

Food variously recorded—Vines, larvae of *Phalaenides glycine* (Lep.), and larvae of *Galeruca semipullata* (Col.).

Coreidae.

8. *Leptoglossus australis*, F., (*Cimex*) Syst. Ent., p. 708 (1775).

Two specimens taken sitting openly on foliage, Bora Bora, Society Is., 15.vi.25 (*L.E.C.*).

Also specimens in the B.M. Coll. from New Hebrides, New Caldeonia and Samoa.

Previously recorded from—

Tahiti, Mayr, (*Theognis*) Reise Novara Hem., p. 104 (1866).

Fiji, Kirk., (*Theognis*) Proc. Linn. Soc. N.S.W., vol. xxxiii, p. 352 (1908).

Recorded as a pest on Cucurbitaceae in Samoa.

9. *Liorhyssus hyalinus*, F., (*Lygaeus*) Ent. Syst., iv, p. 168 (1794).

Two specimens from a coral promontory on blossom. One specimen from the reef-islet of Motu-moute, Bora Bora, June 1925 (*L.E.C.*).

Cosmopolitan.

10. *Leptocoris ahnnei* nom. nov.

= *L. taitensis*, Cheesman, Ann. Mag. Nat. Hist., Ser. 9, vol. xviii, p. 369 (1926). Preoccupied by *Leptocoris* (*Lygaeus*) *taitensis*, Guérin.

In 1830 Guérin (Voy. Coquille Ins., vol. ii, p. 178 (1838)) described and figured *Lygaeus taitensis* from Tahiti. According to Mr. W. E. China this is undoubtedly a *Leptocoris*. There is, however, some doubt as to the identity of Guérin's species. In the first place he gives the length as 23 mm. and the breadth 3 mm. This is evidently an error, and the length should be about 13 mm. The description of the insect also differs from the figure; for Guérin describes the membrane as yellowish, while it is dark green in the figure and strongly resembles that of *Leptocoris insularis*, Kirk. Unfortunately Guérin's type cannot now be found in the National Museum at Paris. However, as far as can be judged from the description and the figure, *Leptocoris taitensis*, Guérin, is distinct from *Leptocoris taitensis*, Cheesman, so that it becomes necessary to rename my species. I therefore take the liberty of dedicating it to Monsieur Ahnne, Président de la Chambre d'Agriculture des Établissements français de l'Océanie.

11. *L. marquesensis*, Cheesman, Ann. Mag. Nat. Hist., Ser. 9, vol. xviii, p. 368 (1926).

Three specimens taken among low herbage at sea-level, Fatuhiva, Marquesas Is., 6.i.25 (*St. George Exped.*).

Lygaeidae.

12. *Graptostethus vitiensis*, Kirk., Proc. Linn. Soc. N.S.W., vol. xxxiii, p. 354 (1908).

One specimen taken among low herbage at 1500 ft. on the hills above Papeete, Tahiti, 10.iii.25. Twelve specimens among grass at sea-level, Raiatea, Society Is., 25.vii.25 (*L.E.C.*).

Previously recorded from—

Fiji, Kirk., *loc. cit.*

13. *Clerada apicicornis*, Sign., In Maillard's Notes sur l'Île de la Réunion Ins., p. 28 (1862).

One specimen taken at light, sea-level, Raiatea, Society Is., 3.vi.25 (*L.E.C.*).

Cosmopolitan.

14. *Pamera nigriceps*, Dall., List II, p. 577 (1852).

One specimen from Tahiti, taken at sea-level in grass on the borders of the lagoon, April 1925. Two specimens from Raiatea, Society Is., in short herbage on the borders of the lagoon and at light.

Also specimens in the B.M. Coll. from Fiji, Hawaiian Is. and N.S. Wales.

Previously recorded from—

Phillipines, Dallas, (*Rhyparochromus*), *loc. cit.*

Tahiti, Stål, Enum., iv, p. 152 (1874).

15. *Pamera pacifica*, Stål, Enum., iv, p. 149 (1874).

Very numerous in all moist localities from sea-level to 2000 ft. among low herbage by the margin of streams. Tahiti, Raiatea and Bora Bora, Society Is. Also taken near Lake Vaihiria, Tahiti, 8 miles inland.

Also specimens in the B.M. Coll. from Samoa.

Previously recorded from—

Fiji, Stål., *loc. cit.*

MIRIDAE (CAPSIDAE).

16. *Hyalopeplus pellucidus*, Stål, Eugen. Resa Ins., p. 255 (1859).

Twenty-two specimens taken at light by Miss Longfield, Hiva-oa, Marquesas Islands, Jan. 1925 (*St. George Exped.*).

Previously recorded from—

Hawaii, Stål, *loc. cit.*

17. *Nesodaphne knowlesi*, Kirkaldy, Proc. Lin. Soc. N.S.W., 33, p. 381 (1908).

Eutinginotum raiateae, Cheesman, Entomologist, vol. lix, p. 266, pl. iii (1926), syn. nov.

One specimen at light at 1000 ft., N. Tahiti, April 1925. Very numerous at light, sea-level, Raiatea, May 25th–June 7th, 1925. One specimen in grass on the borders of the lagoon, Bora Bora, June 1925 (*L.E.C.*).

Owing to Kirkaldy's bad description of this species, there was some doubt as to its identity. I have now seen the type of Kirkaldy's species and there is no doubt that my species is identical with *Nesodaphne knowlesi*.

18. *Creontiades insularis*, Popp., Finsk. vet. Soc., 53, No. 3, p. 1 (1911).

Fairly numerous on Raiatea and Bora Bora from sea-level to about 500 ft. on shaded slopes, May 1925 (*L.E.C.*).

Previously recorded from—

New Caledonia, Poppius, *loc. cit.*

19. *Cyrtorrhinus riveti*, Cheesman, Ann. Mag. Nat. Hist., Ser. 9, vol. xix. p. 94 (1927).

Two specimens taken among *Tradescantia* on the banks of a stream at sea-level, Tahiti, May 1925 (*L.E.C.*).

REDUVIIDAE.

20. *Ploiaria collenetti*, Cheesman, Ann. Mag. Nat. Hist., Ser. 9, vol. xix, p. 95 (1927).

Eight specimens taken by Mr. Collenette under bark, Fatu-hiva, Marquesas Is., Jan. 1925 (*St. George Exped.*).

21. *Ploiaria* sp.

Numerous at light, sea-level, Tahiti, 25.vi.26. Valley of Fanui, Bora Bora, at light, 20.vii.26 (*L.E.C.*).

As only females were taken and these were damaged, I think it advisable to wait until more material is available before attempting to describe this species.

22. *Peregrinator biannulipes*, Sign., (*Opiscoetus*) Ann. Soc. Ent. France, p. 69 (1861).

Ten specimens (four immature) taken under bark on Tahuata, Marquesas Is., 1925 (*St. George Exped.*). Two specimens at Taravaou, Tahiti, taken under bark of *Inocarpus edulis*, the wood of which was being destroyed by very numerous larvae of *Cyllene crinicornis*.

Cosmopolitan.

NABIDAE.

23. *Nabis nigrolineata*, Distant, (*Sastrapada*) Ann. Mag. Nat. Hist., Ser. 9, vol. vi, p. 159 (1920).

Numerous in grass and *Juncus* on the shore belt, Tahiti, Raiatea and Bora Bora, April–Sept. 1925 (*L.E.C.*).

Previously recorded from—

New Caledonia, Distant, *loc. cit.*

24. *Nabis capsiformis*, Germar, In Silberm. rev., v, p. 132 (1837).

One specimen beaten out of bracken at 1500 ft., Hitiaa, Tahiti, July 1925 (*L.E.C.*).

Cosmopolitan.

GERRIDAE.

25. *Gerris discolor*, Stål, Eugenie Resa Ins., p. 265 (1859).

Very numerous in small streams, backwaters of rivers, etc., Tahiti, Raiatea and Bora Bora. Taken from sea-level to 500 ft. (*L.E.C.*).

Previously recorded from—

Tahiti, Manila, China, Stål, *loc. cit.*

Java, Kar-Nikobar, Tahiti, Mayr, Reise Novara Ins., p. 172 (1866).

26. *Halobates sobrinus*, Buch., White Voy. Chall. Zool., vol. vii, pt. ii, p. 47, pl. 1, fig. 7.

Taken by St. George Expedition in sheltered bays on the islands of the Marquesas, and in the coral lagoons of the Tuamotus (off the ocean shore). Taken off the north coast of Tahiti, where they were very numerous on the lagoon.

Previously recorded from the Pacific.

VELIIDAE.

27. *Velia taipiense*, Cheesman, Ann. Mag. Nat. Hist., Ser. 9, vol. xviii, p. 366 (1926).

Four specimens taken in the backwaters of the river Taipi, Nuku-hiva, Marquesas Is., Jan. 1925 (*St. George Exped.*).

28. *Microvelia prompta*, Cheesman, Ann. Mag. Nat. Hist., Ser. 9, vol. xviii, p. 364 (1926).

Twenty-four specimens (eight immature) from Tahiti, April 1925. Extremely numerous in pools, streams, backwaters, etc., from sea-level to 1000 ft. In a stream at Fanui, Bora Bora, Society Islands, June 1925 (*L.E.C.*).

Notonectidae.

29. *Anisops* sp.

One specimen taken north of Tahiti in a pool two miles inland; eight specimens from Lake Vaihiria, Tahiti, 1925 (*L.E.C.*).

Heteroptera previously recorded from French Oceania.

Plataspidae.

Brachyplatys capito, Mont., Ann. Soc. Ent. Belg. Brux., vol. 38, p. 249 (1894).

Type in the B.M. Coll.

Pentatomidae.

Arma emarginata, Stål, Eugenie Resa Ins., 1859.

This species is now known under the name *Apateticus bifidus*, Laporte de Castelnau (*Edessa*), Silb. Rev. Ent., vol. i, p. 36 (1833).

This is a South American species. In 1859 Stål, *loc. cit.*, referred a ♀ specimen to this species although it differed in certain characters from the typical form. It is extremely unlikely, however, that the Tahiti specimen was conspecific with the American *nigrospinis*, Dall., and it is highly probable that this Tahiti species was really the superficially similar *Platynopus melacanthus*, Boisd., which is common throughout the South Pacific islands, and which I took on Tahiti and Bora Bora.

Coreidae.

Diactor discolor, Stål, Oefu. Vet. Ak. Förh., p. 235 (1854).

Later Stål referred this species to *Anisoscelis* and queried the locality (Enum. Het., i, p. 233).

Rhopalus pictipes, Stål, Eugen. Resa, Ins., p. 239 (1859).

This species is now known under the name *Corizus pictipes*, Stål. Stål in 1870 did not reproduce the name of this species with Tahiti as its habitat, therefore this locality was probably given in error.

Lygaeidae.

Nysius spurcus, Stål, *loc. cit.*, p. 243.

Distant considers that the locality was probably given in error.

N. sordidus, Stål, *loc. cit.*, p. 242.

N. californicus, Stål, *loc. cit.*, p. 242.

"One specimen reported from Tahiti."

Rhyparochromus vinulus, Stål, *loc. cit.*, p. 246.

This species is now known under the name of *Pamera vincta*, Say (Het. Hem. N. Am., 1831).

R. ochroceras, Stål, *loc. cit.*, p. 245.

This species is now known under the name of *Pamera bilobata*, Say (Het. Hem. N. Am., 1831).

MIRIDAE (CAPSIDAE).

Capsus taiticus, Stål, *loc. cit.*, p. 257.

C. pacificus, Stål, *loc. cit.*, p. 256.

My grateful thanks are due to Mr. W. E. China for his unwearied patience in assisting me to name these species.

NEUROPTERA.

MYRMELEONIDAE.

1. *Distoleon bistrigatus*, Ramb., Neuroptera, p. 391 (1842).

Among grass, Faka-rava, Tuamotus, and Raiatea, Society Is. Very numerous among grass on the coast of Bora Bora, June 1925 (*L.E.C.*).
Originally described from Tahiti. Also recorded from Australia, Fiji.

HEMEROBIIDAE.

2. *Megalomus* sp.

Taken at light by Miss Longfield, on Hiva-oa, and Tahuata, Marquesas Islands, 1925 (*St. George Exped.*).

3. *Micromus* sp.

One specimen taken at light two miles inland, N. Tahiti, March 1925 (*L.E.C.*).

CHRYSOPIDAE.

4. *Chrysopa ramburi*, Schneid., Mon. Chrys., p. 107, pl. 34 (1851).

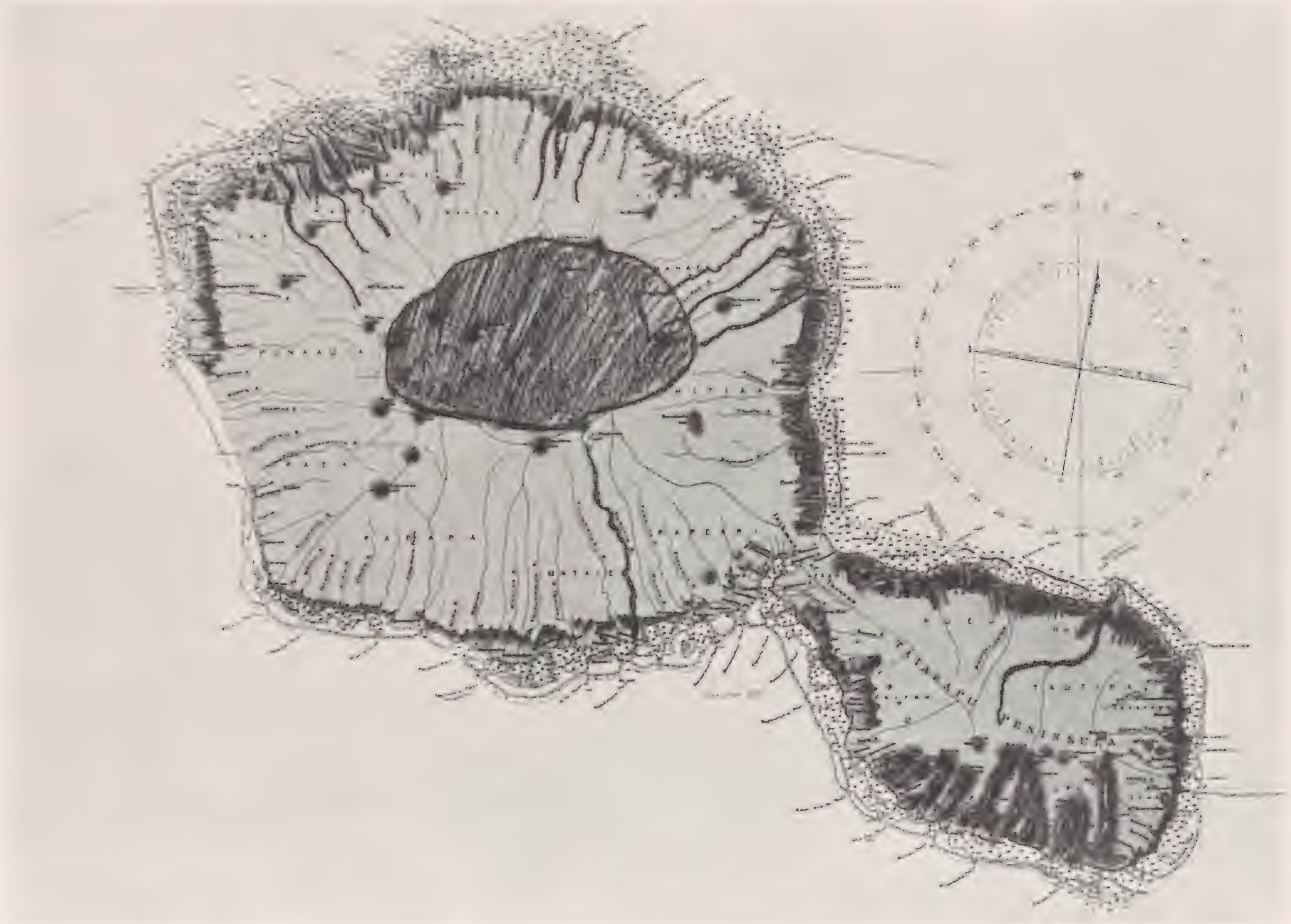
Taken on N.W. Raiatea, May 1925. On the coast and in the interior at about 1500 ft.

5. *C. basalis*, Walker, Cat. Neur., B.M., p. 239 (1853).

Taken on Hiva-oa, Tahuata, Fatu-hiva, Marquesas Is., Jan. 1925. Faka-rava, Tuamotus, Feb. 1925 (*St. George Exped.*). On the coast and at light, N.W. Raiatea, May 1925. Bora Bora and Tahiti, March–August, very numerous (*L.E.C.*).

6. *C. flaveola*, Schn., *loc. cit.*, p. 75, pl. 11.

One specimen from Tahuata, one specimen from Hiva-oa, Marquesas Is., Jan. 1925. Four specimens from Raiatea, Society Is. Sea-level, at light and in low herbage.



L. E. Cheesman. *By kind permission of Messrs. Witherby.*

MAP OF TAHITI, Shewing Trails Cut for Collecting Purposes.

TAHITI SCRUB.

By kind permission of Messrs. Witherby.

Photo. L. E. Cheesman.

Photo. L. E. Cheesman. *By kind permission of Messrs. Witherby.*

THE ISLAND OF BORA BORA.

7. *C. oceanica*, Walker, *loc. cit.*, p. 238.

Taken on the coast and at light, N.W. Raiatea and Bora Bora, May–June 1925 (*L.E.C.*).

8. ? *C. microphya*, Mcl., Ann. Mag. N.H. (5), xii, p. 300 (1883).

Six specimens from Faka-rava, Tuamotus, Feb. 1925 (*St. George Exped.*).
Previously recorded from Tahiti—
Chrysopa v-rubrum, Br., Reise Novara, p. 39 (1866).
C. ramburi, Schneid., *loc. cit.*
C. flaveola, Schneid., *loc. cit.*

My thanks are due to Mr. D. E. Kimmins for kindly determining these species.

Explanation of Plates XIV–XVI.

Plate XIV.

Map of Tahiti showing trails cut for collecting specimens.

Plate XV.

Tahiti scrub.

Plate XVI.

The island of Bora Bora.

EXTRA WINGS IN LEPIDOPTERA

By E. A. Cockayne, D.M., F.R.C.P.

[Read April 6th, 1927.]

Plates XVII–XIX.

In Bateson's classical work on extra appendages in insects he found in the case of legs only one exception to the law he formulated that extra appendages are paired and in secondary symmetry with one another. With the much larger number of records now available the exceptions to his law are larger in number too, although they form only a small proportion of the total.

In the case of extra wings he was unable to find a single example which conformed with his law, and was obliged to conclude that the duplication of wings differed in its mechanism from that of the other appendages.

In a paper published in the *London Naturalist* I collected as far as possible all the references to extra wings in Lepidoptera and from the descriptions and figures grouped them to the best of my ability, but found it impossible to classify some owing to the inadequate description and others owing to the imperfect development of the extra part or parts. I arranged them in three groups.

I. Simple Duplicity. Repetition of a wing or part of a wing, the extra wing being in structure a wing of the same side as the original wing. Both wings may be perfect and of full size, but more often they are reduced in size and have an incomplete neuration. This is especially noticeable in the case of the extra wing. The extra wing may be a fore- or hind-wing and may be situated in front of, behind, over, or under the original wing.

II. Repetition of a wing or part of a wing, which in structure belongs to the opposite side of the body to the original wing. It may lie (*a*) in front with its costa apposed to the costa of the original wing, (*b*) behind with its posterior margin apposed to the posterior margin of the original wing, (*c*) above with its upper surface facing ventrally and apposed to the upper surface of the original wing, (*d*) below with its under surface facing dorsally and apposed to the under surface of the original wing.

III. Two extra wings or parts of wings in secondary symmetry in accordance with Bateson's Law. Reduplication may take place in the long axis of the insect, horizontal reduplication, in front of or behind the original wing, or at right angles to the long axis, vertical reduplication, over or under the original wing.

In the second group I placed nine specimens, but an examination of the *Lasiocampa quercûs* and the *Agriades coridon* reported in this paper satisfied me that some of these follow Bateson's Law and ought to have been placed in the third group. The *quercûs* figured by Gauckler is almost exactly like the one described below, the *quercûs* figured by Wiskott appears to differ only in having the fused extra parts entirely separate from the original wing, and the *Crateronyx dumi* figured by Wiskott seems to be built on the same plan, although the separation of the extra parts from the original wing is much less complete than in my *quercûs*. Two of these were mentioned by Bateson, but not having seen the specimens themselves or diagrams of their neuration he

failed to recognise their true character from the figures. The *Abraxas grossulariata*, which I have recently examined superficially, appears to be similar in structure. Its neuration looks much too complex for it to be a single extra wing in the mirror image position. Thus with one doubtful exception, Wiskott's *Crocallis elinguaria*, in which the arrangement cannot be seen clearly in the figure, the whole of group II*a* can be removed to group III.

Only one insect, an *Epiblema ustulana*, was placed in group II*b*. This moth has a normal right fore-wing and behind it in a reversed position so as to resemble a fore-wing of the opposite side lies a second fore-wing, but there is no hind-wing. This might be explained by supposing that the damage which caused the reduplication of the fore-wing completely destroyed the imaginal disc of the hind-wing, but it seems to me that there is an alternative explanation. For this moth to conform with Bateson's Law there ought to be a third fore-wing, a mirror image of the second one, lying behind the other two. The second extra wing and the hind-wing may have been prevented by pressure from developing, in which case the *ustulana* would also belong to the third group.

In group II*c*, in which the extra wing lies above the original wing, I placed one example, an *Apatura iris*, and must now add the female *Agriades coridon* and the male *Saturnia pavonia* described and figured below.

In group II*d*, in which the extra wing lies below the original wing, I placed a *Samia cecropia*, but on referring to the figure I feel uncertain whether it should be left in this group or placed in group I as an example of simple repetition. Gregson's *Arctia caia*, figured by Mosley, has come into my possession through the kindness of Mr. Tonge from Dr. Chapman's teratological collection. At first sight it appears to fall into group II*d*, but a careful examination revealed a small pale chitinous process firmly fixed just below and in front of the extra wing. This must, I think, be regarded as a second extra wing, which has been almost completely aborted. This specimen gives the key to the other examples in groups II*c* and *d*, and I believe that in all of them a second extra wing has been completely or almost completely suppressed. That suppression of extra parts can occur is shown very clearly by the *Pachyprotasis rapae*, L., figured and described in our *Proceedings* for 1923, pp. lii and liii. In this saw-fly there are only two tarsi, but the presence of five calcaria shows that the second supernumerary tarsus and one calcar have been suppressed. Similar examples could be cited, for it is by no means an isolated case.

If it be accepted that these moths are examples in conformity with Bateson's Law, but with one of the supernumerary wings suppressed, the second group would disappear altogether. The laws governing the reduplication of wings would then fall into line with those of legs, and two groups, one in which there is simple duplicity and one in which there is a pair of extra appendages in secondary symmetry, would remain. It is unlikely that the mechanism of reduplication is different in the case of wings and legs, and a simple explanation, which brings the two into agreement, must necessarily be a probable one.

Taku Komai has described a new mutant of *Drosophila melanogaster* called "Crippled" in thirty cases of which there was reduplication of a meso- or metathoracic leg. The reduplication was neither a simple repetition nor did it follow Bateson's Law like the mutant "Reduplicated." In some the whole limb and in others only a portion was doubled, and the reduplication was either horizontal or vertical. In all cases one leg or one branch was in the normal position and direction and the other was its mirror image. Superficially they resemble the reduplicated wings in group II and it is possible

that in both the same law is obeyed. In spite of this new evidence that there is a third form of reduplication of appendages in insects I think the explanation which I have given for these extra wings in the mirror image position is the true one.

But even if this be admitted, simple repetition is apparently much commoner in the wings of Lepidoptera than in the appendages of other orders. It is improbable that this is actually the case, and the apparent discrepancy may be due to suppression of one member of the extra pair in some of these cases too. In the examples of simple duplicity, in which the extra wing lies over or under the original wing and in which both lie the same way up, there may have been suppression of an extra wing, which would have lain the opposite way up between the two which have developed, and it is not unlikely that in some of those described a very much aborted appendage would be found in this position if they were dissected completely. The *Naenia typica* figured by Wiskott is a clear example of simple repetition and cannot be explained in this way, but in many of the others which I have placed in the first group suppression of a second extra wing may have occurred. If my conjecture be correct, that suppression of a part is a common phenomenon, not only would the laws governing the reduplication of wings in Lepidoptera and the other appendages in all orders be the same, but the numerical ratio between those which follow Bateson's Law and those in which simple repetition occurs would be the same also. The supposition that the suppression of parts so voluminous as the wings of Lepidoptera is much commoner than that of other appendages, which are smaller and develop in a simpler manner, seems to me to be more reasonable than the supposition that they differ in a way so fundamental as their mode of regeneration.

The *Pieris brassicae* figured by Gauckler, placed in the first group in my earlier paper, and the *Eupithecia castigata*, unclassified, appear to be almost exactly like the interesting specimen of *Earias biplaga* described below. In both there is a partial double wing with two nervures, each structurally a nervure 1, in secondary symmetry with one another, lying behind one of the fore-wings, and both conform with Bateson's Law. The *Agriades coridon* from the Bond collection figured by Mosley has always been described as an example of an extra hind-wing lying above the original hind-wing. Through the kindness of Mr. Douglas Pearson I have been enabled to examine it and find that the supposed extra hind-wing is really a double fore-wing so fused that only the posterior part of each is left. The two nervures are both like a nervure 1 and both anterior and posterior borders are clothed with cilia like those of the posterior border of a fore-wing. Finally the original fore-wing and the extra double one spring from a common base and move together. The *Agrotis puta* figured and described below seems to be identical in structure, but it is imperfectly expanded and rather crumpled at the tip. The *Polyommatus icarus* figured by Honrath and recorded by Rühl and Tutt is similar. Although the figure does not show the neuration distinctly, there appears to be a partial double wing fused with the posterior part of the left fore-wing, the anterior part of which is a mirror image of the posterior part of the original wing and the posterior part a mirror image of the anterior. The description of a male *Agriades coridon* given by Tutt is incomplete but sufficiently full to show that it bears a general resemblance to those just mentioned. He gives the following account of the affected wing. "An abnormal wing, far longer and broader than usual, with an indentation in the middle of the hind-margin, tending to show that it is a double wing each half of which has nearly

all the spots of a wing reduced in size, on the under-side." No doubt this wing consists of an original and two extra wings all fused together. Bond's *Omphaloscelis lunosa* with the right fore-wing much broader and differently formed is most likely another example. The *Limenitis populi* ab. *tremulae* figured by Wiskott has a lobe with only three nervures attached to the posterior aspect of the left hind-wing and is much more probably an instance of a fused double wing than of simple duplicity as I considered it to be in my first paper.

It is likely that all and certain that some of these insects just cited are examples of fused double wings conforming with Bateson's Law, and in all of them the greater part of both extra wings has been suppressed. The fact that so great a degree of suppression has occurred in so many examples of horizontal reduplication appears to me to strengthen my case very greatly, that complete suppression is common in vertical reduplication.

Frohawk's *Agriades coridon* differs from all the others in some respects. Only that part of the wing distal to the discoidal cell is tripled, and far from suppression having taken place there are extra nervures present.

Schultz records an example of *Parnassius discobolus*, Stgr., with a deep indentation in the termen of the right fore-wing. An extra nervure between 3 and 4 runs from the discoidal to the indentation. Mr. Rait-Smith has a similar specimen of *Polyommatus icarus*, Rott. In this the left hind-wing is rather short and broad and an extra nervure between 3 and 4 runs from the discoidal to the termen, which at this point is very deeply indented, and in each cell so formed there is an elongated marginal lunule. Other examples of a similar kind have been reported, but although they are doubtless caused by injuries, which might have resulted in the production of extra wings had they been more severe, they cannot be counted as examples of extra wing formation.

The only example of bilateral extra wings which cannot be attributed to homoeosis is that described by Tannreuther. They were found in a larva of *Pieris rapae*, L., killed thirty hours before pupation and lay in the mesothorax. They resembled normal wings in shape, but had no nervures and only a few minute tracheoles between the two single layers of hypodermal cells. The author gives figures of the microscopical and macroscopical appearance and says that the sections gave no clue to their origin.

Reduplication of wings must be a very rare condition. With the addition of those which are described for the first time in this paper I have only collected fifty-nine examples, though no doubt some records have escaped my notice and there must be some which have never been recorded. Extra wings replacing legs or patagia are instances of substitution homoeosis and belong to a different teratological class. These have been omitted, but Rogenhöfer's *Zygaena minos* which is an example of homoeotic regeneration has been included. This and Tannreuther's bilateral case stand apart. Of the remaining fifty-seven thirteen fall into group I, six into group II, twenty-three into group III, and fifteen are unclassified. Since casual accidents are the cause one would expect to find an even distribution amongst the different families, genera and species, but a glance at the list will show that this is not the case. There are several species in which the abnormality has been reported more than once, *Agriades coridon* (4), *Saturnia pavonia* (3), *Samia cecropia* (3), *Lasiocampa quercûs* (3) and *Dasychira pudibunda* (2), but of these *L. quercûs* is the only one in which the extra wings show a close similarity in all the recorded examples.

Summary.

As I am afraid the discussion of individual cases in the body of the paper may have made it difficult to follow, I will give a brief summary of the conclusions at which I have arrived. The regeneration of wings in Lepidoptera obeys the same laws as the regeneration of the other appendages in all orders. Most extra wings conform with Bateson's Law. There are two extra wings or parts of wings forming a pair in secondary symmetry. The one nearer to the original wing is structurally like a wing of the opposite side of the body and is a mirror image of the original wing, and the one further away is a mirror image of the one nearer to the original wing. Most extra wings which lie in front of or behind the original wing are fused double wings of this nature, but are generally recorded as single extra wings. When regeneration takes place in the vertical direction over or under the original wing, one member of the pair of supernumerary wings is often suppressed, and if the suppressed wing be the one nearer to the original, the one which develops is like a wing of the same side in structure, but if it be the one further from the original which is suppressed the one which develops is like a wing of the opposite side in structure. Simple duplicity is as rare in the wings of Lepidoptera as in the other appendages in all orders. In this form of regeneration there is only one extra wing, which in structure is a simple repetition of the original wing.

Descriptions of New Cases, etc.

Earias biplaga, Walk. Male.

A. W. J. Pomeroy. C69924—B.8. Ibadan, Nigeria, 27.i.1925.

On the right side there is an extra fore-wing 5·5 mm. long × 2·5 mm. wide lying behind and slightly above the normal fore-wing, which is 10 mm. long × 5 mm. wide. The extra wing is firmly attached by a common base to the normal wing and both move together. In the diagram the extra wing is drawn detached and too far behind the other, of which in reality it hides the basal part of nervure 1. The neuration of the original right fore-wing is abnormal; 2 and 3 are stalked instead of arising separately and 4 bifurcates about two-thirds of the distance between its point of origin and the termen. The extra wing is very small, but is evidently a double wing in structure; the borders are both posterior borders and the only two nervures are nervures 1 structurally, as is shown by their shape, by the absence of the dense scales of a costa, and by the arrangement of the white scales on the underside near their bases. Between them is a ridge with scales like those on the subcostal and median nervures, but no actual nervure is present, although three folds corresponding with interneural folds run to the termen. The anterior part of the extra wing is a mirror image of the posterior part of the original wing and the posterior part is a mirror image of the anterior part of the extra wing, so that the specimen conforms with Bateson's Law. The moth was bred and fortunately the pupa case was kept. It is, I believe, the only one from a teratological specimen of this kind which has been examined. There is a complete wing-case for the extra wing having the same relation to the wing-case of the original wing as the extra and original wings have to one another in the imago. This proves conclusively that the damage which caused the abnormality occurred during larval life. Probably all similar monstrosities originate in the larval stage, and this explains why they are met with as frequently in species such as the Lasiocamps, which make tough cocoons, as in those in which the pupa has no protection at all. The larval skin was softened with potash and spread out on a slide with very fair success, but no larval abnormality could be seen. (Pl. XVII, fig. 4, and Pl. XIX, figs. 6 and 7.)

Agrotis puta, Hb. Female.

F. J. Coulson, Merton, iv.1913.

There is an extra mesothoracic wing on the right side arising from an independent base just behind the original fore-wing. It is very small, $4\frac{1}{2}$ mm. × 3 mm.; the original wing is $13\frac{1}{2}$ mm. × 6 mm. at the discoidal and is rather narrower and paler than the left fore-wing. The anterior part of the extra wing is folded over and has only two nervures. The posterior one is like nervure 1 of the fore-wing in shape and the inner margin has long cilia like those along the inner margin of a fore-wing, but owing to the folding of the wing the exact shape of the anterior nervure cannot be made out and the absence of scales makes it impossible to determine whether the front part is structurally like the anterior or the posterior part of a wing. Probably the extra wing is a partial double wing, its anterior part being a mirror image of the posterior part of the original wing and its posterior part being a mirror image of the anterior part. If so it would be an example of Bateson's Law closely resembling the *Earias biplaga*. (Pl. XVII, fig. 5, and Pl. XIX, fig. 1.)

Agriades coridon, Poda. Female.

Mason Coll.

This specimen was originally described and figured by Mosley who said there was a small extra hind-wing on the left side lying above the normal hind-wing and his description was copied by Tutt. The insect has passed into the hands of Mr. Douglas H. Pearson and he has kindly lent it to me and allowed me to relax it. Mosley's account is entirely wrong. In reality there is a small partially double fore-wing lying behind the original fore-wing. It arises from the same base as the original fore-wing and moves with it. The original fore-wing is reduced in length, being 15 mm. long × 10 mm. wide, compared with the right fore-wing which is 17 mm. long × 10 mm. wide. The extra wing is 10 mm. long × 2 mm. wide. The inner margin of the original fore-wing is slightly concave instead of slightly convex, and nervure 1 is nearer to it than usual. Nervure 2 branches about halfway from its point of origin, but otherwise the neuration is normal. The underside of the original fore-wing is rather pale; the basal spot in the discoidal cell is small and that between 1 and 2 is absent. The large spot of the subterminal row which lies across 1 is missing and the dark mark internal to the corresponding lunule is missing also. The extra wing has two nervures which are mirror images of one another and both its outer and inner margins are clothed with hairs resembling those on the inner margin of the original fore-wing. There are no spots on its underside. The anterior part is a mirror image of the posterior part of the original wing with a nervure which in structure is a nervure 1, and the posterior part is a mirror image of the anterior with another nervure 1. If a line be drawn through the middle of the wing from base to termen, the part in front of the line is seen to be structurally the same as the posterior part of a right fore-wing and the part behind the line the same as the posterior part of a left fore-wing. The specimen has an original wing and two incomplete extra wings fused together in secondary symmetry and it conforms perfectly with Bateson's Law. (Pl. XVII, fig. 2, and Pl. XIX, fig. 8.)

Lasiocampa quercûs, L. Male.

New Forest. Bred by A. Bowen.

Two incomplete extra fore-wings united together lie in front of the original wing partially separated from it by a deep cleft. The original wing is narrower than usual, but its neuration is normal except that the costal nervure is common to it and the first extra wing for the greater part of its course and then divides giving one branch to the

costa of the original wing and the other to that of the first extra wing. The extra wings are curled at the edges making the neuration difficult to discern. The arrangement is such as would be seen if a plane mirror were placed at right angles to the surface of a normal fore-wing in its long axis with its reflecting surface directed towards the costa so as to cut through the middle of the discocellular nervure. The part seen in the mirror would represent the first extra wing and the part in front of the mirror would represent the second extra wing. The discal cell common to the extra wings is very narrow and the white discoidal spot is much reduced in size. The left antenna is short but the legs are normal.

The specimen obeys Bateson's Law of reduplication. (Pl. XVIII, fig. 4, and Pl. XIX, fig. 2.)

Agriades coridon, Poda. Male.

F. W. Frohawk, Swanage, 1923.

The right hind-wing is partially triplicated in a manner different from any recorded specimen, with which I am acquainted. There is evidence of injury at the anterior end of the distal extremity of the discoidal cell, where there is a depression visible when the insect is viewed from beneath, and a slight folding of the membrane so that nervure 3 appears to arise from beneath 4, 5 and 6. The costal (8) and subcostal nervures are normal. The anterior part of the discocellular nervure is compressed and folded so that 4 and 6 arise close together and at first run parallel to one another and 5 must run in contact with one of them as it only becomes visible when they separate. The white discoidal mark of the primary or original part of the wing is indicated by a line of white scales between 4 and 6, which can be seen in the photograph. There is a distinct indentation of the margin just behind 3 which shows the division between the original part of the wing and the first extra part. The first extra part appears to be a mirror image of the original and consists of the distal portion of the wing, which includes the nervures numbered 3 to 6 in the diagram. Next comes the second extra part, a mirror image of the first extra part, comprising the distal portion of the wing containing nervures 6 to 3. Since only the middle of the wing is triple, the rest of the wing is the posterior part of the original or primary wing with the normal nervures, the median and nervure 1. Nervure 2 is abnormal springing from the extremity of the median instead of its posterior aspect nearer to the base. The white discoidal mark of the first extra part is normal, but that of the second extra part is very much wider than a normal one. There are, I think, in this part four extra nervures, which account for its unusual width. It is doubtful which they are, but probably the middle one is the true nervure 5, because the white discoidal mark extends further along it than along any of the others. The two nervures on either side numbered x in the diagram are most likely the extra ones. They are all very thin and one is incomplete. All the spots are pushed outwards towards the margin and there are additional ones corresponding to the increased number of cells. The ground-colour between the discoidal mark and the spots is uniformly pale brown instead of being broken by the white patch in cell 3.

I think this interpretation of a very puzzling specimen is correct in the main points. I may sum it up by saying that the distal portion of the anterior part of the wing, the part between the discocellular nervure and the margin, is triplicated with the original part compressed, the first extra part normal, and the second extra part greatly widened and having four extra nervures. It complies with Bateson's Law, the first extra part being a mirror image of the original and the second extra part being a mirror image of the first.

An alternative explanation is to number the nervures from in front backwards 8, 7, 6, 5, 4, 3, 3, 4, 5, 6, 7, 8, 8, 7, 6, 5, 4, 3, 2, 1. At first sight this appears more probable, because

there is no need to assume that any nervures are supernumerary. If, however, it were correct one would expect to find two costal and two subcostal nervures arising from the base to form two complete discoidal cells. Another strong objection is that on this interpretation the hindmost of the three white discal marks extends on to the first of the two extra parts from the second extra part to which it belongs. These two difficulties seem to be sufficiently great to make this alternative explanation untenable. (Pl. XVIII, fig. 3, and Pl. XIX, fig. 3.)

Zygaena filipendulae, L. Male.

F. F. Wood, S. N. A. Jacobs, Ditchling, 1.vii.1925.

On the left side the wings are normal, but on the right there are three fore-wings and one hind-wing. The first, the original, fore-wing arises from a separate base situated a little anterior to that of the left fore-wing and it can be moved independently of the others. The second and third are extra fore-wings in secondary symmetry with the original wing and they arise from a common base and move together. The first extra wing is reversed having its posterior margin in apposition to the posterior margin of the original wing, of which it is the mirror image. The second extra wing is a mirror image of the first extra wing and their costae are apposed. The original wing is nearly as large as the left fore-wing, being 15 mm. instead of 15·5 mm. long, but owing to the posterior margin being curled underneath I cannot measure its width accurately. It appears to be too narrow. Its neuration and pattern are normal, although a considerable number of scales are missing. The first extra wing is 9·5 mm. long and its posterior margin is curled up. Its pattern is normal and its only defect of neuration is that 1*b* ends short of the point of origin of 2. The second extra wing is misshapen and very small, only measuring 6·25 mm. × 3 mm. Nervure 1*b* is missing and there are only three nervures between 1 and 8, probably 3, 4 and 6. The other nervures and the pattern are normal, but there is a deficiency of scales. The right hind-wing is perfect in every respect, but it arises rather far back owing to the wide mesothorax. The legs are all present and are neither reduced in size nor imperfectly developed. I do not know of any other example of a lepidopterous insect with extra wings, which conform to Bateson's Law so completely as this *Zygaena*. The specimen is in the teratological collection of the British Museum. I am indebted to Mr. Hugh Main for the photograph reproduced on Plate XVII, fig. 1. A diagram of the neuration is shown on Plate XIX, fig. 4.

Ematurga atomaria, L. Male.

C. P. Pickett, vi.1906, Folkestone.

Three wings rise from the metathorax, one nearly perfect and two so rudimentary, that it is impossible to be quite sure of the correct interpretation of the specimen. All are firmly welded together at their origin, and so far as can be seen are hind-wings in structure. The uppermost is very narrow and projects backwards, although it arises from the usual point of origin of a hind-wing. Its anterior edge has no cilia, but its posterior edge is ciliated like a hind-wing. This I regard as the original hind-wing. Lying slightly below it and projecting forwards is a much smaller wing with only one recognisable nervure. This is probably the mirror image of the first and is to be regarded as the first extra wing. Arising below this is a wing almost like a normal hind-wing, but poorly pigmented. Nervure 5 appears to be missing, but the remainder of the neuration is normal. There are two frenula visible from below. One is the normal frenulum and the other, which springs from a point close to the junction of this wing with the first extra wing is probably the frenulum of the first extra wing. Unfortunately I broke it off in examining its attachment. This large wing is probably the second extra wing. The

simplest view to take of the specimen is that it is an example of Bateson's Law, with the original wing and the first extra wing in a very rudimentary condition. (Pl. XVII, fig. 3, and Pl. XIX, fig. 5.)

Arctia caia, L. Female.

C. S. Gregson's specimen from Dr. T. A. Chapman's Teratological Collection.

There are two hind-wings on the left side both considerably smaller than the right hind-wing. The original wing lies uppermost and the extra hind-wing, which is the larger, lies beneath with its under surface apposed to the under surface of the original wing, of which it is the mirror image. Both spring from a common base, which also gives origin to a pale chitinous process projecting outwards and downwards. This arises just below and very slightly in front of the extra wing and appears to be a very much aborted second extra wing. Thus there is the original wing above with a pair of supernumerary wings beneath. The hind-wings all arise from a point further back than usual. The two big ones are poorly pigmented and partially folded, but their neuration and markings are normal, although the big submarginal spot in the extra wing does not reach the anterior margin as in the hind-wing of the opposite side. The extra wing has no frenulum. The legs are normal. There is said to be a figure of the insect in Mosley's *Illustrations of Varieties of British Lepidoptera*, but I have been unable to find it in the copies I have seen. (Pl. XVII, fig. 6, and Pl. XIX, figs. 9, 10, 11.)

Agriades coridon, Poda. Female.

Royston, 1923. C. P. Pickett.

There is a very small extra hind-wing 8·5 × 5 mm. on the left side with its lower surface uppermost and its upper surface apposed to that of the normal hind-wing. The spots and neuration of the extra wing, which has been damaged a little after emergence, are normal. Both the fore- and hind-wings on the left side are reduced in size but the legs are unaffected. (Pl. XVIII, fig. 2.)

Saturnia pavonia, L. Male.

A. G. J. Harris, Romsey. Bred April 16th, 1923.

There is an extra metathoracic wing on the left side, 12 mm. long × 5·5 mm. wide lying face downwards over the normal wing. It appears to have a common origin with the normal wing. At the base it is bent upwards and the main portion, which lies horizontally, is slightly creased. The neuration cannot be made out clearly but it is very imperfect. Apparently there are three longitudinal nervures and no discocellular. In coloration and markings the general appearance is that of the underside of a hind-wing, but the ocellus is absent. The original or normal left hind-wing is fully expanded and perfect in neuration, but is a little reduced in size, being a millimetre shorter than the right, and the orange colour is paler. No trace of a second extra wing can be detected above the first. (Pl. XVIII, fig. 1.)

List of all Known Examples.

Group I. Simple Duplicity. Extra Fore-wing.

Samia cecropia, L. Male. Repetition of anterior part of left fore-wing. (Strecher, Bateson.)

Samia cecropia, L. Female. Small right fore-wing in front of original fore-wing, complete but somewhat crumpled posteriorly. (Sampson.)

Naenia typica, L. Two left fore-wings one behind the other, both well developed, but smaller than usual, and apparently with normal neuration. This is incorrectly recorded by Schultz, who states that the left hind-wing is reduplicated. (Wiskott, Schultz.)

Liparis auriflua, Fab. Female. A. W. Mera, Loughton, 1915. Extra fore-wing lying over the posterior part of the left fore-wing. The extra wing is long, narrow and crumpled, so that the neuration cannot be made out, and the original wing is also rather narrow. (Cockayne.)

Extra Hind-wing.

Gonepteryx rhamni, L. J. Woodgate, Brandon, 1873. There is a small extra right hind-wing under the original. Westwood gives a full description and beautiful figures of the neuration. (Woodgate, Meldola, Westwood.)

Aglais urticae, L. There is a small extra right hind-wing over the anterior part of the original wing. Westwood gives a good description and clear figure of the neuration. It was taken by Doubleday at Epping. (Westwood.)

Colias eurytheme, Boisd. Male. Texas, Joicey Coll. A small curled-up extra right hind-wing lies over the original wing, which is reduced in size. (Talbot.)

Cosmotriche potatoria, L. Female. Joicey Coll. A very small extra right hind-wing, normal in shape, lies over the original wing, which is pale and reduced in size. (Talbot.)

Saturnia pavonia, L. Female. Germany, Joicey Coll. An extra left hind-wing lies above and in front of the original wing. Both are small, but their neuration appears to be normal. (Talbot.)

Zygaena filipendulae, L. Tatchell, Hants, 1913, Joicey Coll. An extra left hind-wing lies above and behind the original. Both are reduced in size. (Talbot.)

Diloba caeruleocephala, L. R. Freer, Rugeley, 1896, Brit. Mus. A small extra left hind-wing lies below and in front of the original. (Cockayne.)

Melanargia galathea, L. Vauncey Crewe and Bright Collections. There are two hind-wings on the right side one under the other. Both are a little smaller than normal and there is a branched nervure in the lower.

Saturnia pavonia, L. Female. Two small hind-wings arise on the left side, both with perfect neuration. The second arises on a level with and immediately behind the first. (Mason, Bateson.)

Group II. Extra Wing a Mirror Image of Original Wing.

(a) *In front of original wing.*

Crocallis elinguaria, L. (Wiskott.) (Doubtful.)

(b) *Behind original wing.*

Epiblema ustulana, Hb. (Gillmer.)

(c) *Above original wing.*

Apatura iris, L. (Wiskott.)
Agriades coridon, Poda. (Described above.)
Saturnia pavonia, L. Male. (Described above.)

(d) *Below original wing.*

Samia cecropia, L. (Rau and Hosenfelt.) (Doubtful.)

Group III. Two Extra Wings or Parts of Wings in Secondary Symmetry in Conformity with Bateson's Law.

(a) *Extra wings in front of original wing.*

Lasiocampa quercûs, L. Male. (Described above.)
Lasiocampa quercûs, L. Male. (Gauckler.)
Lasiocampa quercûs, L. Female. (Honrath, Wiskott.)
Crateronyx dumi, L. (Wiskott.)
Abraxas grossulariata, L. (South.)

(b) *Extra wings behind original wing.*

Fore-wing Reduplicated.

Zygaena filipendulae, L. (Described above.)
Agriades coridon, Poda. Female. (Mosley, Tutt.)
Pieris brassicae, L. (Gauckler.)
Eupithecia castigata, Haw. (Wiskott.)
Polyommatus icarus, Rott. (Rühl, Tutt, Honrath.)
Earias biplaga, Walk. (Described above.)
Agrotis puta, Hb. Female. (Described above.)

Hind-wing Reduplicated.

Limenitis populi, L. ab. **tremulae,** Esp. (Röber, Wiskott.)
Brephos parthenias, L. (Wiskott.)
Agriades coridon, Poda. Male. (Tutt, Barrett.)
Agriades coridon, Poda. Male. (Frohawk, described above.)

(c) *Extra wings above original wing.*
(d) *Extra wings below original wing.*

Fore-wing Reduplicated.

Zygaena exulans, Hoch. (Chapman.)
Chalcosia venosa, Walk. (Green, Hampson, Tutt.)

Hind-wing Reduplicated.

Dasychira pudibunda, L. (Honrath.)
Ematurga atomaria, L. (Pickett, described above.)
Arctia caia, L. (Mosley, described above.)
Arctia caia, L. Vertical reduplication from discoidal cell outwards. (Chapman, Cockayne.)

Position doubtful.

Omphaloscelis lunosa, Haw. (Bond.)

Unclassified.

Extra Fore-wing.

Janthina frivaldskyi, Dup. A narrow extra right fore-wing, anterior part only, lies beneath the original wing. It appears to have the underside uppermost, and if so a second extra wing is probably suppressed and it belongs to group III. (Wiskott.)

Pygaera anastomosis, L. There is a wing-like appendage to left fore-wing. (Schultz.)

Brephidium exilis, Boisd. The right fore-wing is duplicated. (Pearson.)

Heliothis incarnata, Frr. Above the right fore-wing is a narrow folded, crumpled extra wing. (Rangnow.)

Poecilocampa populi, L. There is a rudimentary extra wing in front of the right fore-wing. (Tarbat.)

Ellopia fasciaria, L. There is an extra left fore-wing in front of the original wing. It is very small and twisted and has only one nervure. A subcostal nervure is missing in the original wing and both it and the hind-wing are reduced in size. (Christeller.)

Extra Hind-wing.

Amorpha populi, L. There is a long appendage at the base of the right hind-wing, very rudimentary but scaled. (Sheppard.)

Limnas chrysippus, L. A small hind-wing without markings lies above the original wing on the left side. (Byatt and Poulton.)

Orthosia laevis, Hb. There is an extra hind-wing on the left side. (Treitschke, Schultz.)

Macrothylacia rubi, L. There is an extra hind-wing, 6 mm. wide, immediately above the left hind-wing. (Speyer.)

Dasychira pudibunda, L. There is an extra right hind-wing. (Wiskott.)

Cabera exanthemata, Scop. There is an extra wing in the form of a long narrow process under the left hind-wing. (Slevogt.)

Wing not Specified.

Luperina testacea, Hb. Five wings. J. A. Clark Coll. (Cockayne.)

Zygaena filipendulae, L. Five wings. (Bright.)

Phalaena sp. Five wings. (Borckhausen quoted by Van Heyden.)

Homoeotic Extra Wing.

Zygaena minos, Schiff. An extra fore-wing is inserted on the left side above and between the original wings. The shape is more like that of a hind-wing, but the colour and pattern are more like those of a fore-wing. The neuration is quite abnormal. (Rogenhöfer.)

Bilateral Extra Wings.

Pieris rapae, L. In a larva there was an extra wing on each side in the mesothorax. The additional wings were symmetrical in form and position. (Tannreuther.)

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Explanation of Plates XVII–XIX.

Plate XVII.

Fig. 1. *Zygaena filipendulae* with two extra fore-wings in secondary symmetry.
2. *Agriades coridon* (Mason Coll.) with two incomplete extra fore-wings fused together and in secondary symmetry.
3. *Ematurga atomaria* with two extra hind-wings in secondary symmetry with one another.
4. *Earias biplaga* with two extra fore-wings fused together and in secondary symmetry with one another.

Fig. 5. *Agrotis puta* with two extra fore-wings fused together and in secondary symmetry with one another.
6. *Arctia caia* with one extra hind-wing developed and chitinous remnant of second. (Gregson Coll.)

Plate XVIII.

Fig. 1. *Saturnia pavonia* with extra hind-wing lying face downwards over original wing.
2. *Agriades coridon* with extra hind-wing lying face downwards over original wing.
3. *Agriades coridon* with partial triplication of hind-wing and extra nervures. (Frohawk Coll.)
4. *Lasiocampa quercûs* with two incomplete extra fore-wings in secondary symmetry with one another fused with one another and with original wing.

Plate XIX.

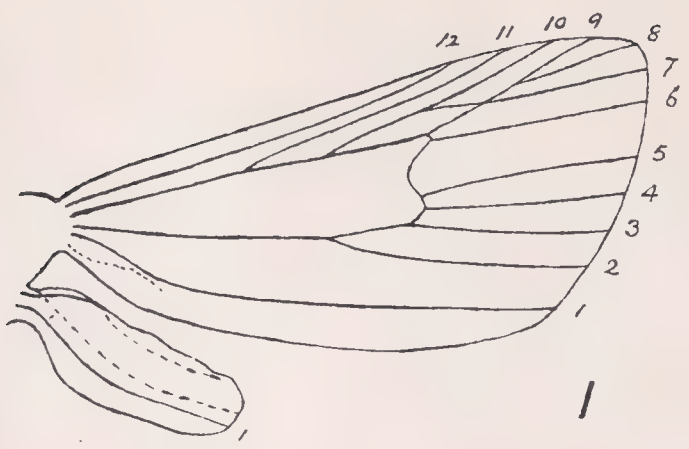
Fig. 1. Neuration of *Agrotis puta* with two incomplete extra fore-wings fused together.
2. Neuration of *Lasiocampa quercûs* with two incomplete extra fore-wings fused with one another and with the original wing.
3. Neuration of *Agriades coridon* (Frohawk) showing partial triplication of hind-wing with extra nervures (x).
4. Neuration of *Zygaena filipendulae* with two extra fore-wings in secondary symmetry.
5. Neuration of *Ematurga atomaria* with two incomplete extra hind-wings in secondary symmetry.
6. Neuration of *Earias biplaga* with two incomplete extra fore-wings fused together.
7. Pupa-case of *Earias biplaga* showing case for the extra wings.
8. Neuration of *Agriades coridon* (Mason Coll.) with two incomplete extra fore-wings fused together.
9. Gregson's *Arctia caia.* Neuration of original wing.
10. ,, ,, ,, Neuration of first extra wing.
11. ,, ,, ,, Bases of wings and chitinous process representing second extra wing.

Photo. E. A. Cockayne. *Vaus & Crampton, Ltd.*

EXTRA WINGS IN LEPIDOPTERA.

Photo. E. A. Cockayne. *Vaus & Crampton, Ltd.*

EXTRA WINGS IN LEPIDOPTERA.



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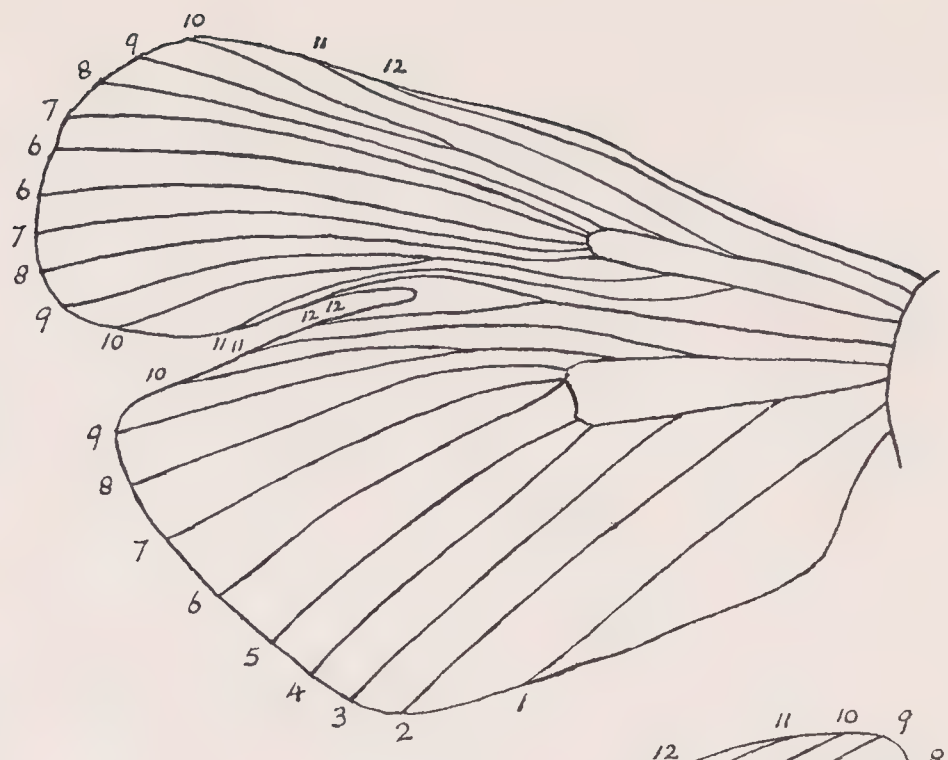

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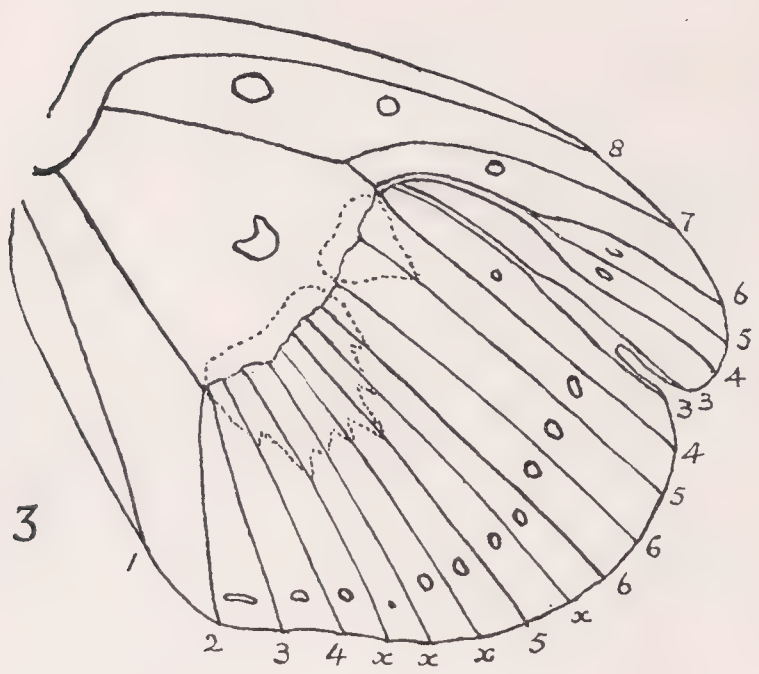

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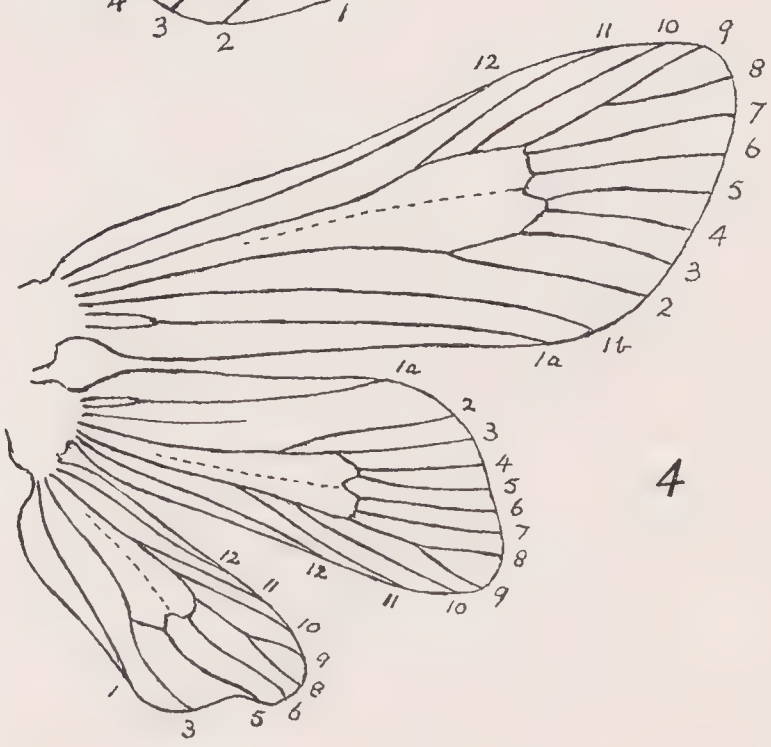

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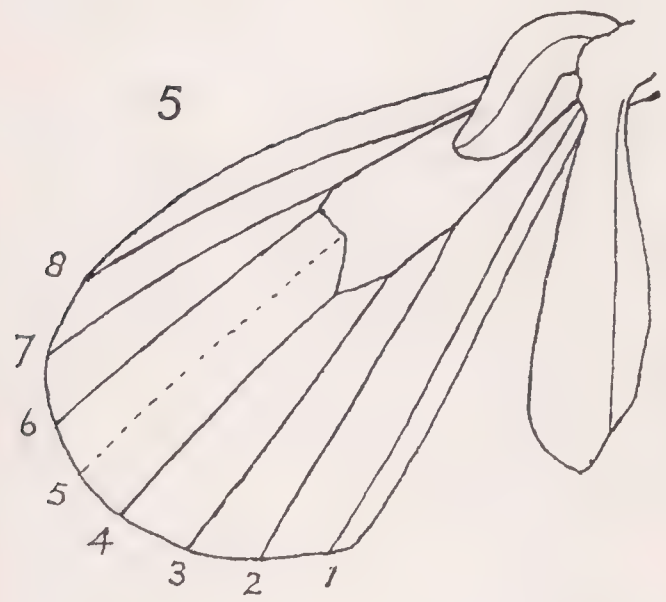

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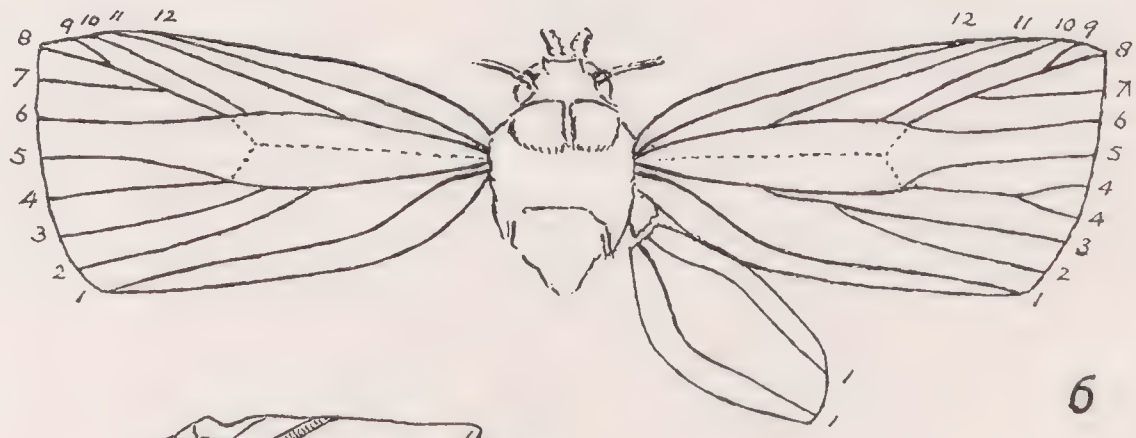

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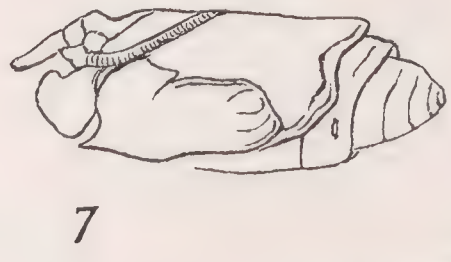

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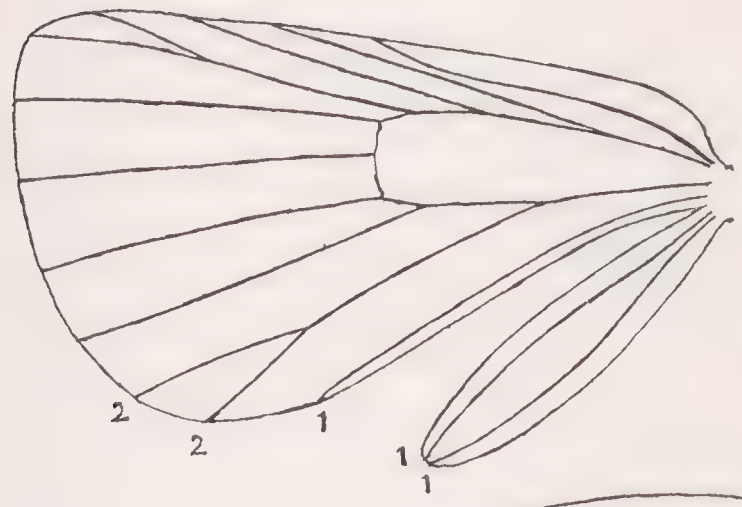

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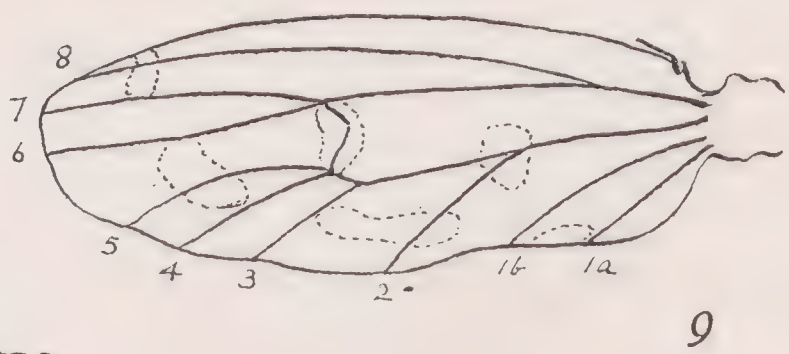

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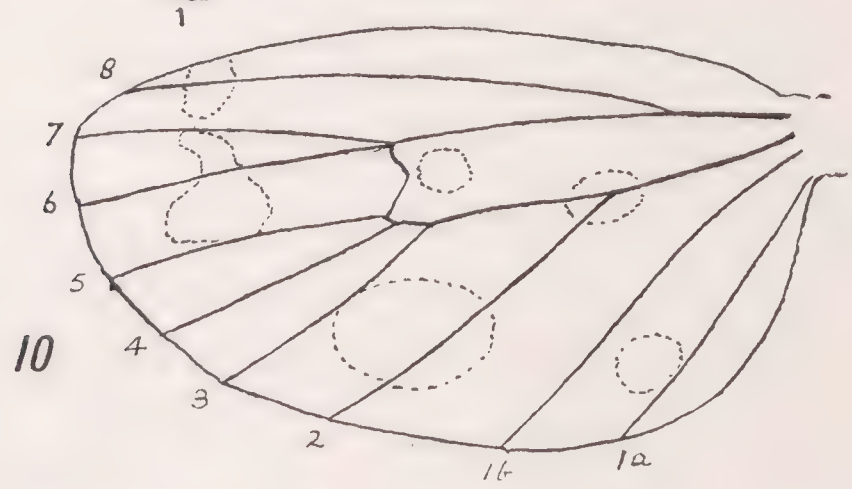

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EXTRA WINGS IN LEPIDOPTERA.

THE LARVAE AND PUPAE OF THE GENUS *HYPERECHIA* (DIPTERA, ASILIDAE)

By W. H. Thorpe, B.A.

(From the Zoological Laboratory, Cambridge.)

[Read April 6th, 1927.]

With Nineteen Text-figures.

The larvae and pupae here described comprise three species of the genus *Hyperechia*: namely, *H. xylocopiformis*, Walk., Bangalore, S. India; *H. consimilis*, J. G. Wood, Nyasaland; and *H. bifasciata*, Grünb. It is owing to the kindness of Prof. E. B. Poulton, F.R.S., that I have been able to examine and describe the material. I also have to thank Major E. E. Austen, D.S.O., of the British Museum (Natural History) for allowing me to examine and describe further material of *H. consimilis*. No larvae of the genus have hitherto been described and only those of very few other species of the subfamily Laphriinae, to which the genus belongs, are known. The material is especially valuable in that it all bears satisfactory specific identification.

There is no need to recount the details of the life-history since these have been fully dealt with by Prof. Poulton in recent volumes of the *Trans. Ent. Soc.* The species are of particular interest both on account of the very perfect mimicry exhibited by the adults, and also because it has been shown that the larva of each species almost certainly preys upon the larva of the particular species of Xylocopid bee which the adult fly mimics. Another interesting point is that the genus *Hyperechia* offers one of the few cases among Asilids in which the larva has been shown conclusively to be carnivorous. In this connection it is interesting to see that there does not seem to be any modification in the structure of the mouth-parts that can be connected with the carnivorous habit. It may be, however, that all the Laphriinae are really carnivorous. As Prof. Poulton has pointed out, now that larvae of this genus are known to be predatory the evidence as to the nature of the food of other Asilids will have to be carefully re-examined.

Both the larvae and pupae differ markedly in many respects from those of all other known members of the subfamily. In the larvae the following points are peculiar. The simple mandible with a deep closed lateral incision for the palpus; the presence of three pairs of contractile processes on abdominal segments 1–7; the slight development of the ventral plate, and the absence of the terminal plate. In the pupae the short mouth-part sheaths, the hypopharyngeal sheath not reaching the "heart-shaped part," are characteristic. From this it will be seen that on larval and pupal characters alone the genus is to some extent intermediate and fits as conveniently into the Dasypogoninae as into the Laphriinae, the larval and pupal keys given by Melin for the Swedish Asilidae being quite inapplicable to this genus.

The terms adopted throughout are those used by Melin, whose work on the Swedish Asilids is the chief source of information as to the biology of the group. Malloch uses the term maxillae for the main pair of jaws owing to the presence of the palpus. It seems fairly clear, however, from Melin's figures and from my

own observations that the palpus does not really spring from the appendage in question, but is attached to the skin of the head. There is no valid reason therefore why the term mandible should not be used. At the same time it should be pointed out that the homologies of the mouth-parts are by no means certain and that the terms are used in the same way as in Melin's paper, because the evidence does not enable one to come to a definite decision and because it is convenient to bring the account into line with the chief descriptions already published.

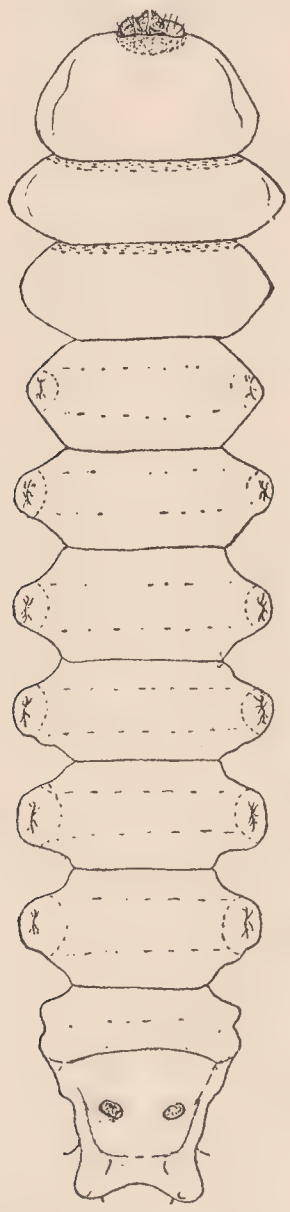

Fig. 1.—*H. xylocopiformis.* Larva. Dorsal view. × 2.

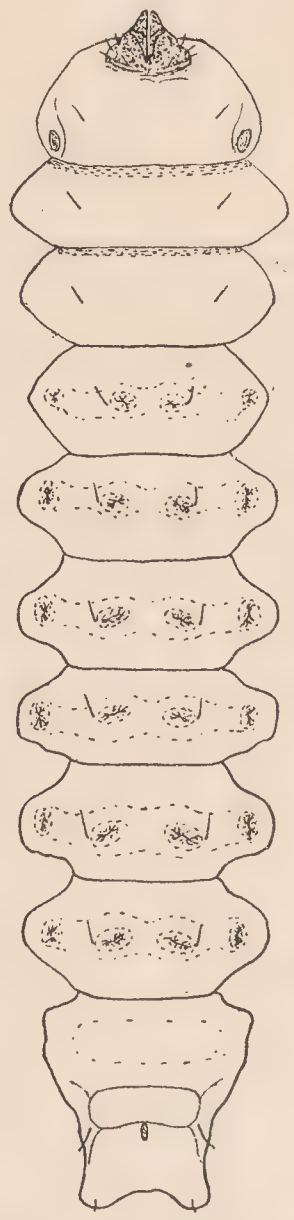

Fig. 2.—*H. xylocopiformis.* Larva. Ventral view. × 2.

I wish to thank Dr. D. Keilin for his readiness to give me the benefit of his wide knowledge of Dipterous larvae.

The specimens described are in the Hope Department of Entomology, University of Oxford.

General Account of the Larvae of *Hyperechia*.

The larvae of two species only are available. They agree so closely that it will be convenient to give a general description first and indicate the specific characters afterwards.

Head. Head capsule brown, about twice as broad as long, with a slightly arched transverse profile; dorsal part strongly chitinised, ventral part of head pale and but slightly chitinised; hind margin straight. Capsule rod broad, unforked, rounded off at the apex, length rather more than twice breadth. Ventral plate small and inconspicuous. Labrum small; sunk between the bases of the mandibles, narrow, claw-like. "Antennae" minute, bud-like, situated dorsally on the anterior lateral angle of the head capsule. Mandibles broad, simple, roughly triangular when viewed dorsally; convex on upper side, concave on underside, flat on inner side with a groove for the maxilla; a deep lateral incision containing

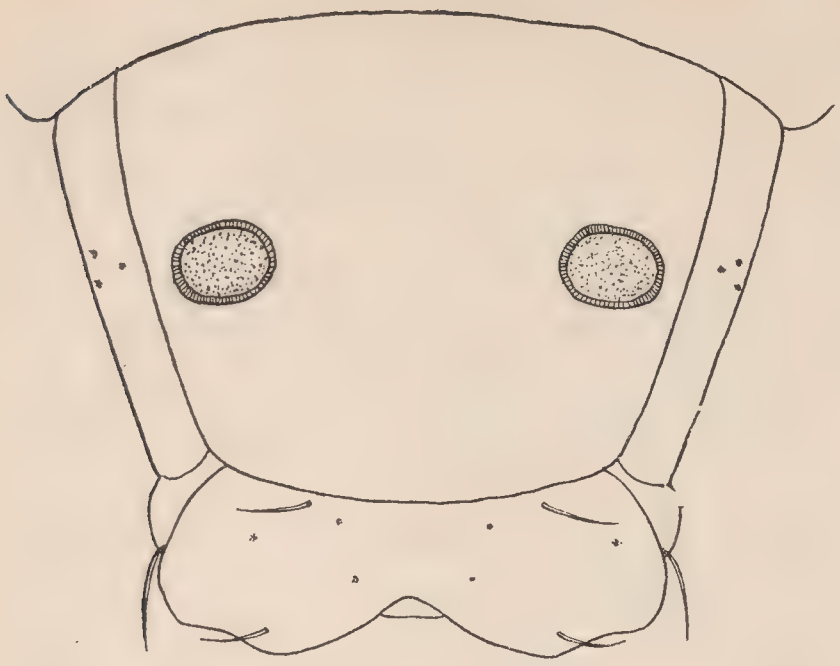

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FIG. 3.—*H. xylocopiformis.* Larva. Terminal segment. Dorsal view. × 8.

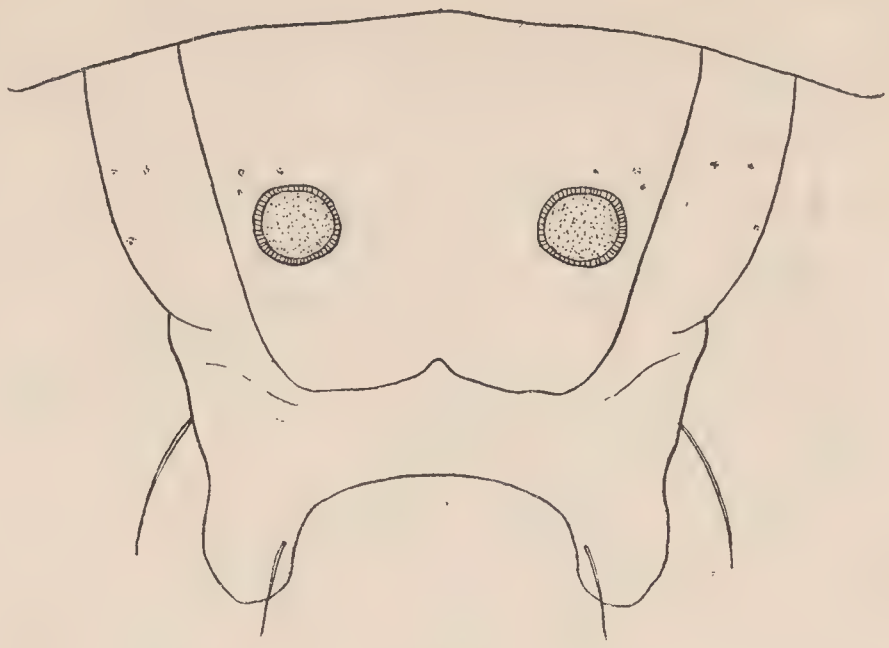


FIG. 4.—*H. bifasciata.* Larva. Terminal segment. Dorsal view. × 8.

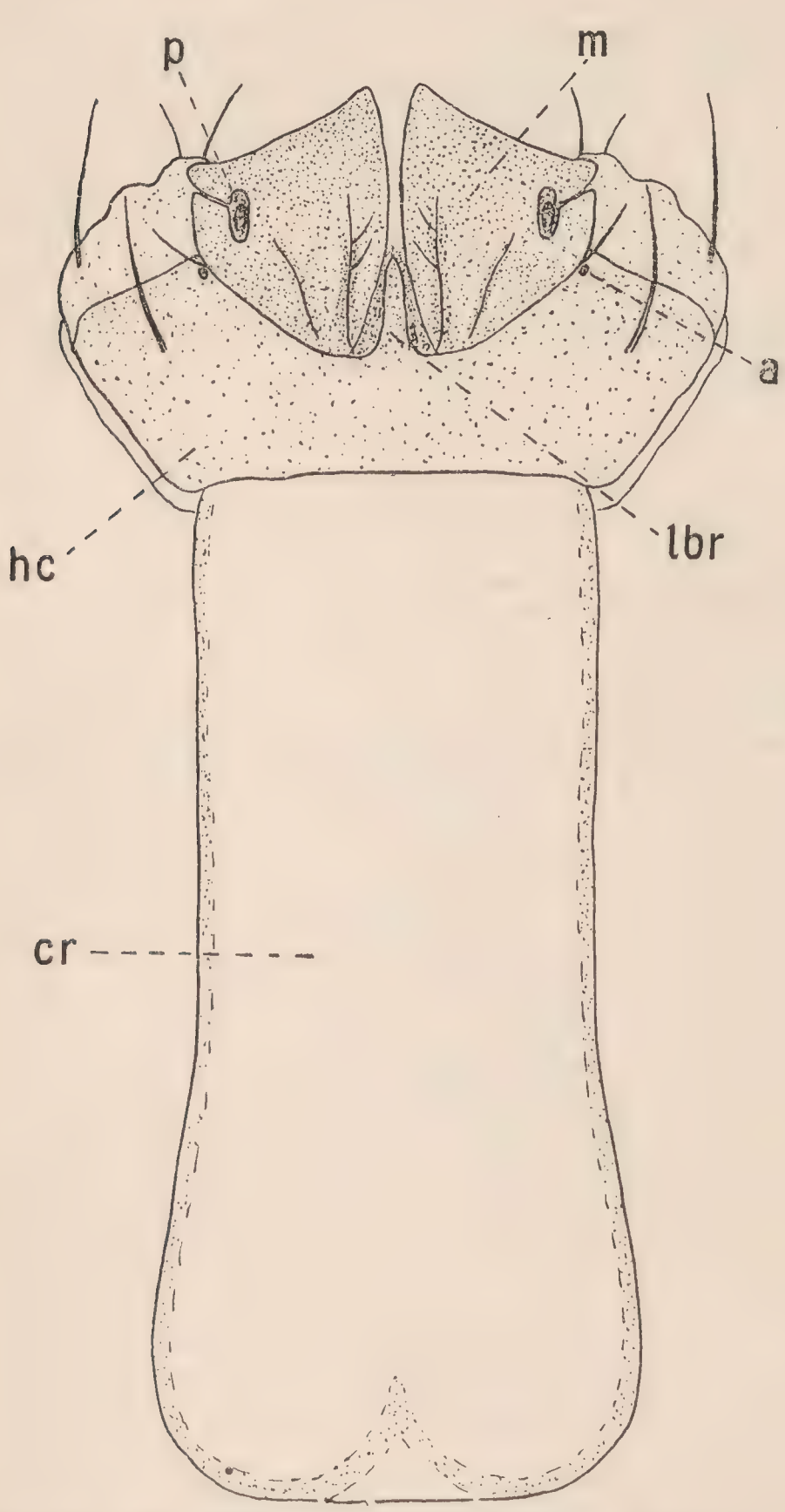


FIG. 5.—*H. xylocopiformis.* Larva. Dorsal view of head. × 20.

a.—Antenna. *c.r.*—Capsule rod. *h.c.*—Head capsule. *lbr.*—Labrum. *m.*—Mandible. *p.*—Palpus.

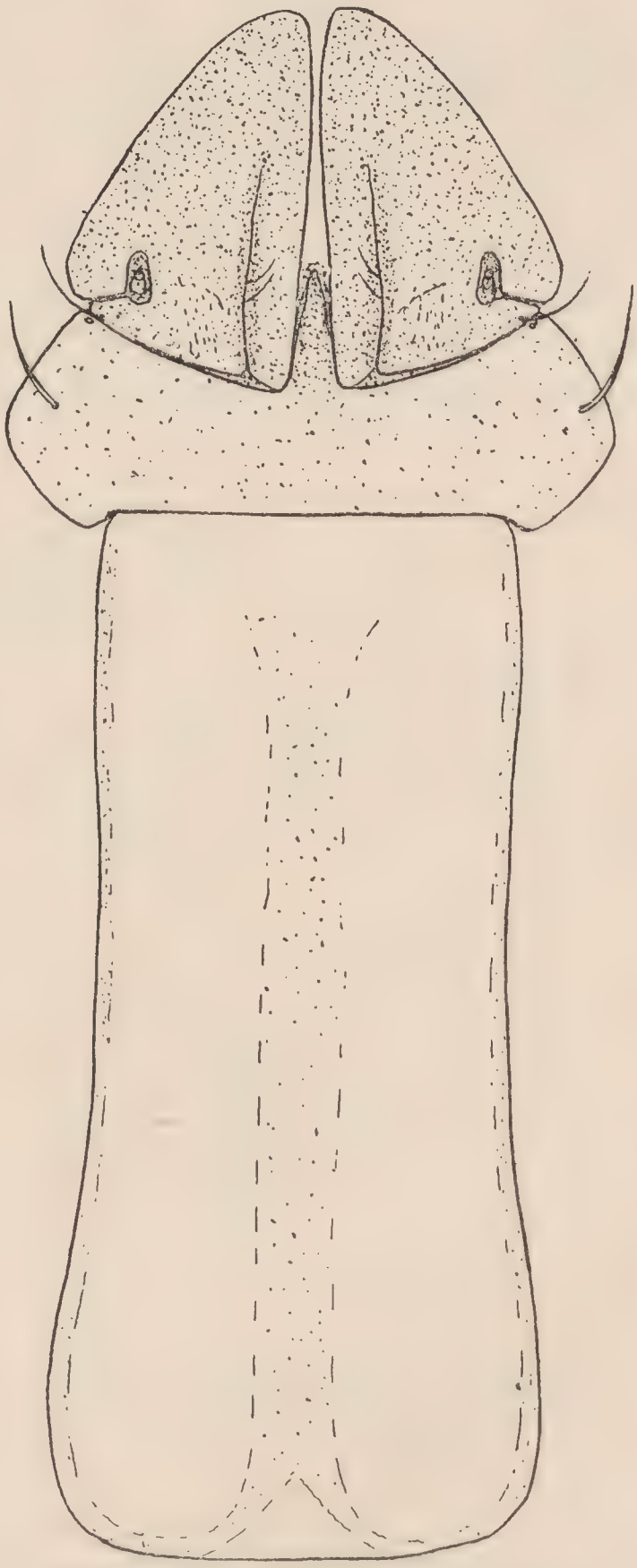


FIG. 6.—*H. bifasciata.* Larva. Dorsal view of head. × 20.

the palpus; a well-marked longitudinal furrow runs parallel with the inner margin, containing two bristles. Maxillae concealed by mandibles, minute, blade-like with a stout spine-like bristle on dorsal edge near apex, attached firmly to the masticating tablet. Pharynx support well developed, with two cylindrical chitinous rods running backwards along the oesophagus for about two-thirds the length of the capsule rod. Bristles of head as follows: One large bristle on each side of the dorsal surface of the head capsule; one small bristle on the head capsule at the base of each mandible, just in front of the antenna; Two bristles, the anterior one small, the posterior one large, on the extreme latero-frontal angles of the head capsule; dorsal surface of mandibles with three bristles situated in or close to the longitudinal groove.

Thorax. Prothorax the longest segment, rounded dorsally, covered with a network of shallow furrows. Apical callosity well developed dorsally, appearing as a semicircular, shagreened area at base of head capsule and narrowing greatly on the ventral surface. Spiracles reniform, lateral. Mesothorax the widest segment of the body, shorter than prothorax. Circular callosities of the meso- and meta-thorax narrow and slightly developed, much less marked than that of the prothorax.

Abdomen. Segments increasing in length towards the posterior end, the 7th being the longest. Segments 1–6 each with a ring of six contractile processes, placed in pairs dorso-laterally, ventro-laterally and ventrally. Those on the first abdominal segment less strongly developed, especially the dorso-lateral pair; processes attaining their maximum development on the 5th and 6th segments. A pair of small bristles ventrally on all the segments of the body, those on the abdomen being placed on the outer side of the ventral contractile processes. Last abdominal segment with a long anterior section bearing a pair of large spiracles. Posterior section with two terminal processes very slightly chitinised at the apex; bearing two or four pairs of terminal bristles. No terminal plate.

Specific Characters of the Larvae.

H. xylocopiformis, Walk.

Length, 4·2 cm.

Width at prothorax, 9 mm. One specimen.

Head capsule uniform dark shining brown; mouth-parts almost black. Lateral angle of mandible well marked, lying far forward; latero-frontal margin of mandible convex. A

Fig. 7.—*H. xylocopiformis.* Larva. Ventral view of head. × 13.

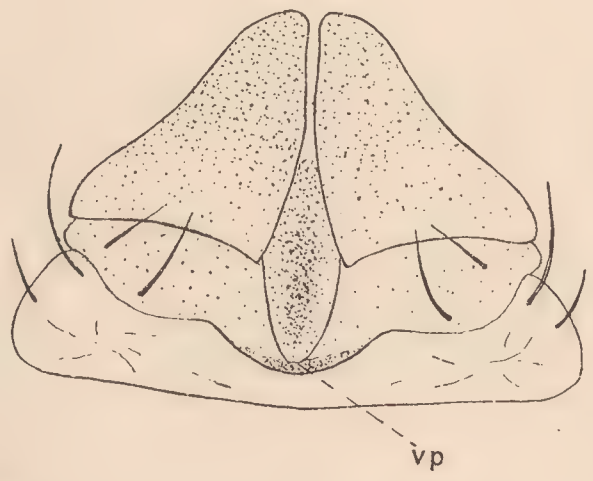


Fig. 8.—*H. bifasciata.* Larva. Ventral view of head. × 13.
v.p.—Ventral plate.

second furrow on the mandibles, less clearly defined than the first, runs diagonally from the inner angle of the mandible towards the palpus. Circular apical callosities of the meso- and meta-thorax very slightly developed. Contractile processes, especially the dorso-lateral pair, on the 1st abdominal segment very slightly developed. Spiracles blackish brown;

anterior pair reniform, posterior pair oval. Terminal abdominal segment bearing four pairs of bristles. Terminal processes short and blunt; a group of three minute brown warts placed laterally at the level of the spiracles and three more at the level of each terminal process.

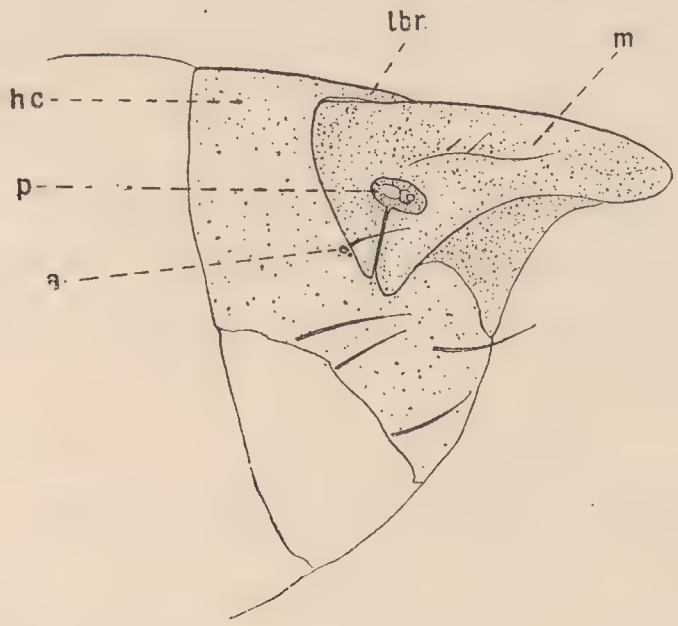


FIG. 9.—*H. bifasciata.* Larva. Lateral view of head. × 18. Lettering as in Fig. 5.

FIG. 10.—*H. xylocopiformis.* Larva. Maxilla and masticating tablet. × 23.

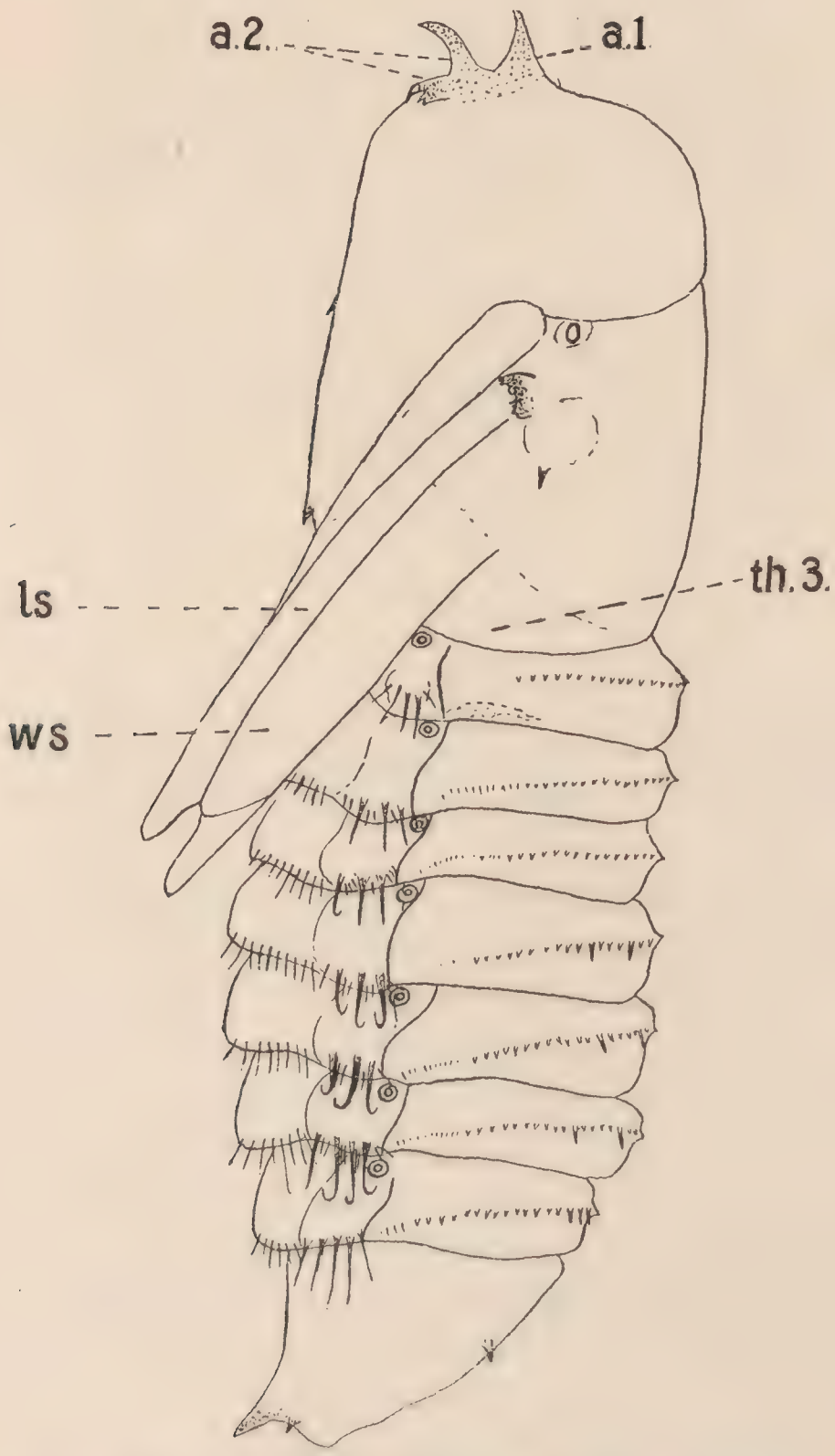


FIG. 11.—*H. consimilis.* Pupa. Lateral view. × 4.
a.1.—Anterior antennal processes. *a*.2.—Posterior antennal processes. *l.s.*—Second pair of leg-sheaths. *th*.3.—Metathorax. *w.s.*—Wing-sheaths.

H. bifasciata, Grünb.

Length, 3·0 cm.

Width at prothorax, 8·0 mm. One specimen.

Head capsule pale dull brown, mottled with small rusty areas. Mouth-parts same colour. Ventral furrow deep; a narrow curved ventral plate. Structure of head capsule as in *H. xylocopiformis*. Capsule rod as in previous species, save that margin and median thickenings more strongly developed. Mandibles larger and longer in relation to width than those of *xylocopiformis*. Latero-frontal margin convex. Contractile processes, especially those on the 1st abdominal segment more strongly developed. Spiracles pale brown. Posterior pair circular. Two pairs of terminal bristles only. Many minute brown warts on dorsal surface of the terminal segment; it is quite uncertain whether these are sufficiently constant for systematic work.

General Account of the Pupae of *Hyperechia*.

Head with well-developed antennal processes 4–5 in number. Anterior processes large, curved, a small bristle at the base of each. Posterior processes with 3–4 teeth which provide valuable specific characters. The front one is the largest and is usually more or

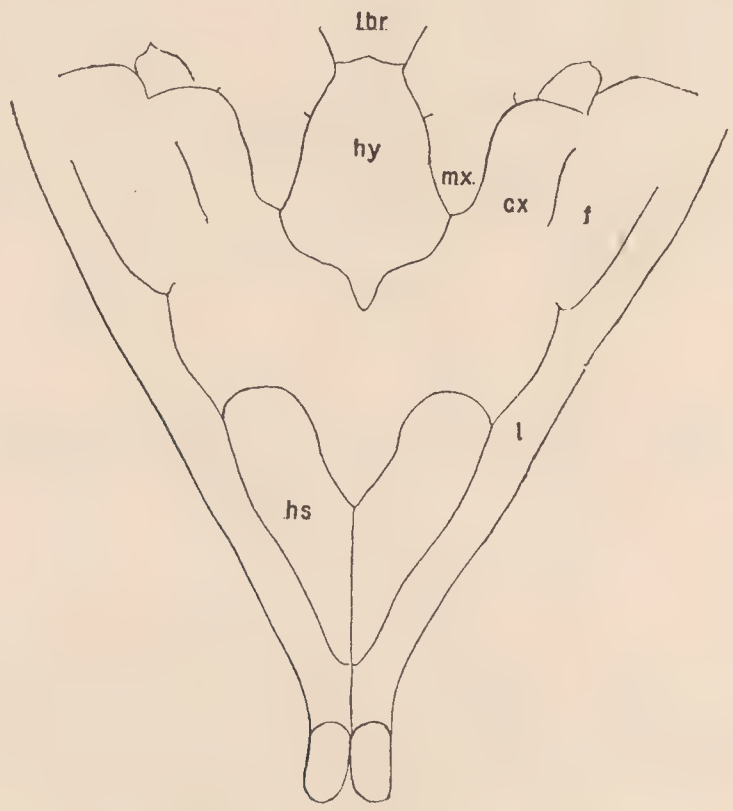


Fig. 12.—*H. consimilis*. Pupa. Sheaths of mouth-parts. × 6. *cx.*—Coxa. *f.*—Femur. *l.*—Prothoracic leg. *lbr.*—Labrum. *hy.*—Hypopharynx. *mx.*—Maxilla. *hs.*—" Heart-shaped part."

less separate from the rest. Lower part of face with spine-like processes, the inner ones arranged in two small transverse rows placed one on either side of mid-line, each row forming a single process with a varying number of teeth; the outer ones single and larger. Mouth-part sheaths short, hypopharyngeal sheath not reaching " heart-shaped part."

Thorax very slightly arched, smooth, without dorsal bristles. At the base of the mesothoracic leg sheaths an epaulette-like toothed process giving useful specific characters.

Abdomen stout, strongly arched dorsally, slightly arched or flattened ventrally. Dorsally segments 1–7 with a curved transverse row of short coarse spines, most strongly developed on segments 5–7, the spines being best developed in the middle of each row. Pleurae with transverse row of bristles, one or two bristles on each segment being large and spine-like, and in some cases curved at the tip. Segments 2–7 ventrally with a transverse row of backwardly pointing bristles; most strongly developed on 6th and 7th segments. Last segment divided into two regions; anterior region with a dorsal transverse row of 2–4 spines on either side of which the spiracles are situated. These are very variable and are

useless as specific distinctions. Posterior part of segment with four strong pointed processes, arranged in a square, the ventral ones being the largest.

Specific Characters of the Pupae.

Specific distinctions are chiefly found in the antennal processes, the processes at the base of the mesothoracic leg sheaths and those on the terminal segment.

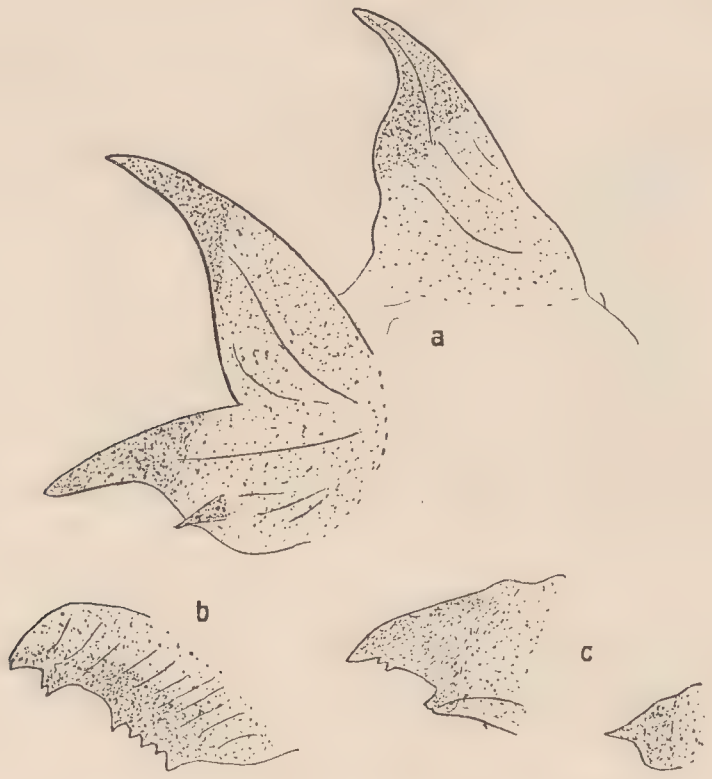
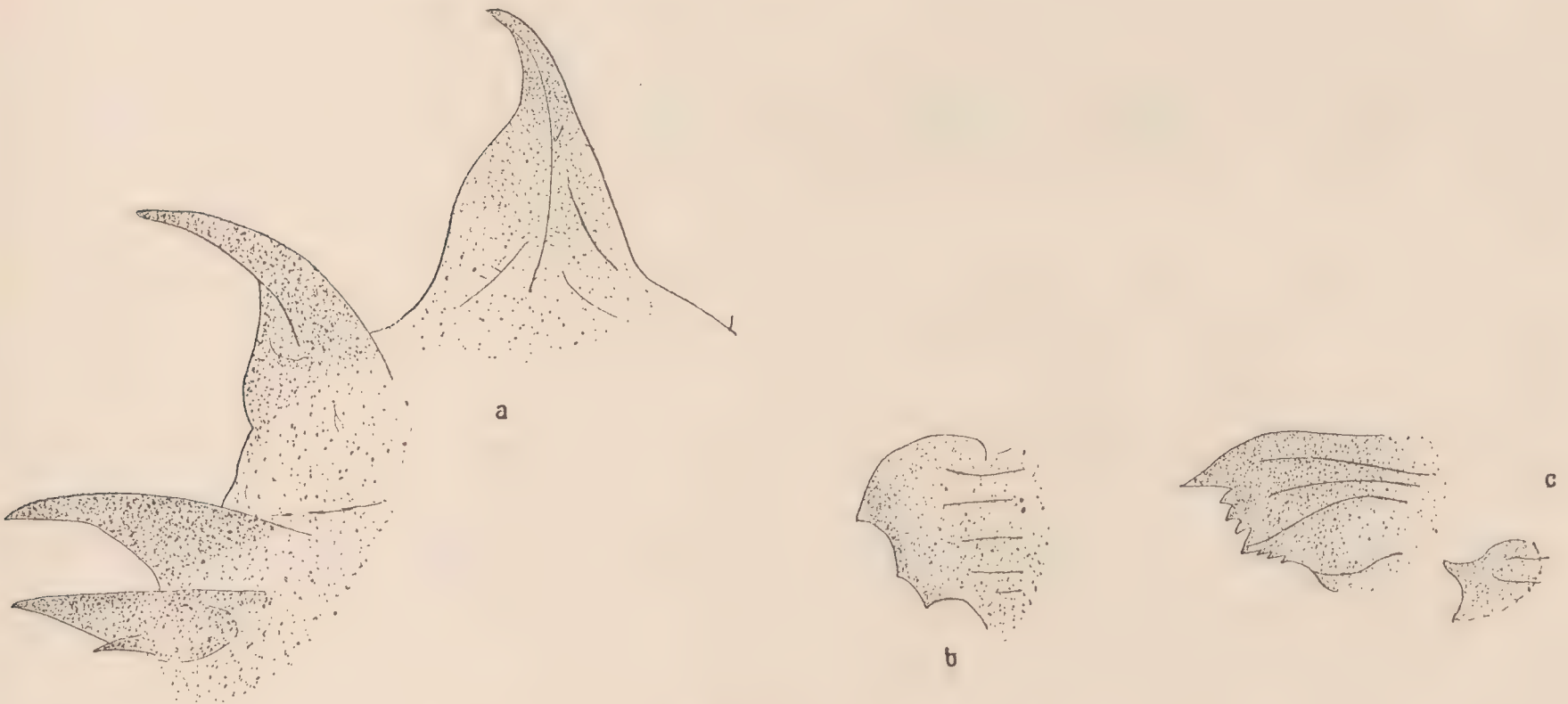


Fig. 13.—*H. consimilis.* Pupa.
a.—Antennal processes. Lateral view. × 13.
b.—Mesothoracic processes. Lateral view. × 18.
c.—Facial processes. Anterior view. × 18.



Figs. 14–15.—*H. xylocopiformis.* Pupa.
a.—Antennal processes. Lateral view. × 13.
b.—Mesothoracic processes. Lateral view. × 20.
c.—Facial processes. Anterior view. × 20.

The antennal processes give by far the most reliable characters, the terminal abdominal spines come next in importance, while the facial and thoracic spines are less satisfactory.

H. consimilis, J. G. Wood. 28 × 9 mm. average of five specimens.

Three posterior antennal processes, the third being a small projection from the second

which forms a well-marked shoulder below it. Processes on mesothorax at base having three projections, the outermost having 4–5 small teeth. Slightly narrowed median facial process when viewed from front, not constricted at base, with three big teeth and sometimes one smaller one. Lateral facial process very broad at base, tapering to a short point.

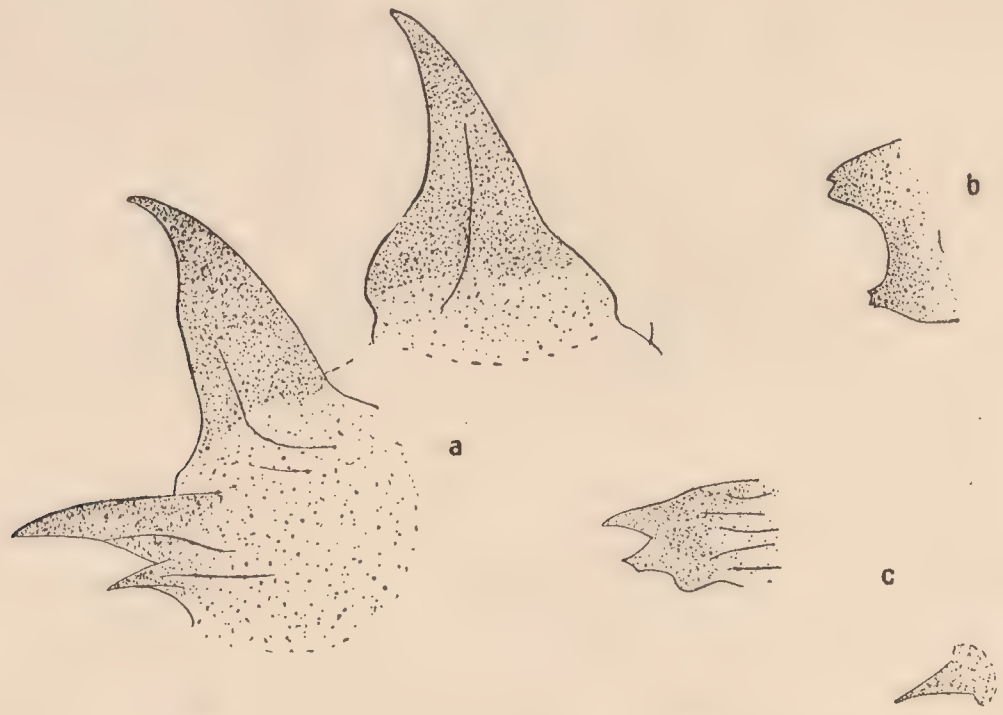


Fig. 16.—*H. bifasciata*. Pupa.
Lettering as Fig. 13. (*a*) × 18; (*b*) × 13; (*c*) × 13.

Posterior abdominal segment having the ventral processes long and acute without a marked shoulder. Dorsal processes small, about one-third length of ventral processes.

H. bifasciata, Grünb. 24 × 6 mm. average of two specimens.

Antennal processes resembling those of *H. consimilis*, but third posterior process larger, nearly half the size of the second which is not produced into a flange or shoulder below it.

Fig. 17.—*H. consimilis*. Pupa. Terminal segment. Dorsal-posterior view. × 15.
d.p.—Dorsal processes. *v.p.*—Ventral processes.

Process on *mesothorax* broad at base with two main projections, one having two teeth, the other three. Median facial processes with three teeth. Lateral process conical, acute, not broadened greatly at base. Posterior segment having the ventral processes long with a slight broadening or shoulder at base. Dorsal processes acute, conical, nearly as large as the ventral processes.

H. xylocopiformis, Walk. 27 × 8 mm. average of five specimens.

Differing from the other two species in possessing four posterior antennal processes; the first large and much arched, nearly as big as the anterior process, the last one a very small

Fig. 18.—*H. xylocopiformis.* Pupa. Terminal segment. Dorsal-posterior view. × 15.

projection from the side of the third. Processes on mesothorax slightly constricted at base, with two or three simple teeth. Median facial processes with five teeth, generally two large

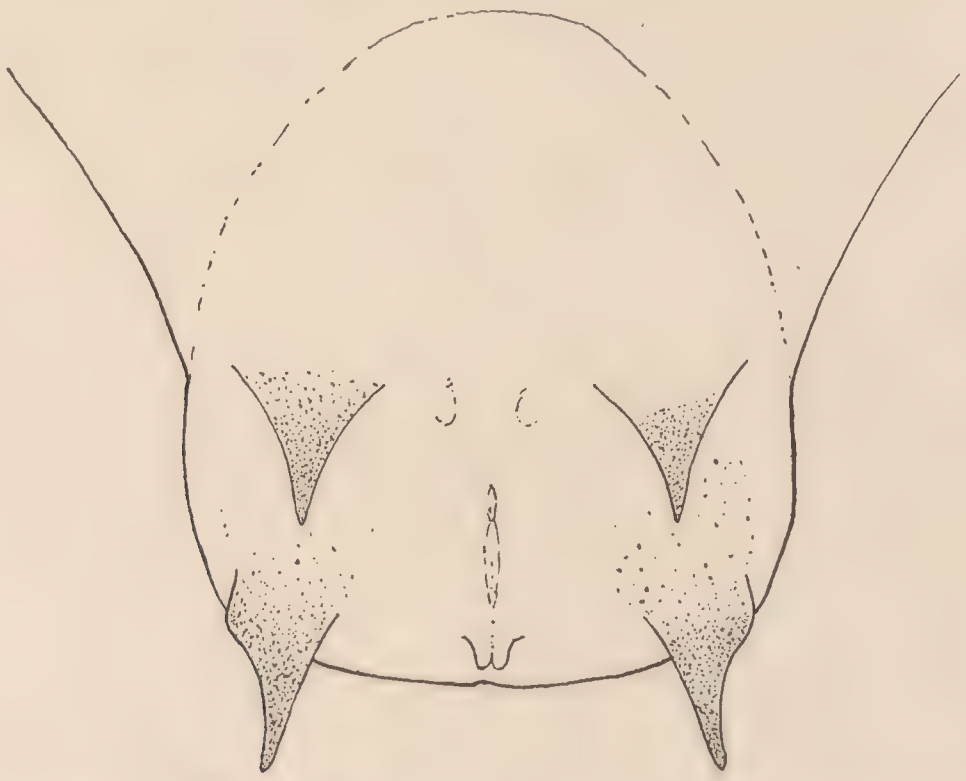


Fig. 19.—*H. bifasciata.* Pupa. Terminal segment. Dorsal-posterior view. × 15.

and three small ones. Lateral process sharply pointed, much widened at base. Posterior segment having ventral processes with a well-marked shoulder. Dorsal processes small.

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—— Proc. Ent. Soc. Lond., 1926, 3rd November, Vol. 1, pp. 1 and 9.

A LIST OF THE *GEOMETRIDAE* (LEP. HET.) KNOWN TO OCCUR IN THE ISLAND OF SÃO THOMÉ, WITH DESCRIPTIONS OF SOME NEW SPECIES COLLECTED BY MR. T. A. BARNS.

By Louis B. Prout.

[Read April 6th, 1927.]

Plate XX.

So far as I can ascertain, nothing whatever has hitherto been published on the Geometridae of this island, with the exception of the few new species described by Warren in volumes viii and ix of *Novitates Zoologicae* and based on a small collection made by Mocquerys and now in the Tring Museum. Mr. Barns has therefore, as regards this family, traversed an almost untrodden field; and although one might have anticipated more extensive results, the following catalogue marks a very substantial advance.

Mr. Barns' collection consisted of 189 specimens, in 38 species, the only long series being the extremely variable *Cleora subcincta*, Warr. At least 23 species or subspecies appear to be new to science, but two of these—a *Xanthorhoë* and a *Protosteira* (?)—have not been considered adequate for describing. The single Oenochromine and two new Hemitheinae are described in Seitz' *Macrolepidoptera*, vol. xvi; the rest of the novelties, namely 1 *Comostolopsis*, 2 Sterrhinae, 6 Larentiinae and 9 Geometrinae are herein described. Adding 6 species in the Tring Museum which were not found by Mr. Barns, the total number of Geometridae known from the Island is thus 44.

Most of the São Thomé species belong to widely distributed African groups. Until more far-reaching morphological studies have been made of the interrelationships of the individual species, it would be somewhat rash to predicate a definitely close connection with the eastern island fauna (Madagascar, Mauritius, etc.); but in some cases—*Comostolopsis fluorita*, *Eois pyrauges*, *Collix psephena*, *Cabera subalba*, the single specimen of *Racotis squalida* and one or two *Cleora*—there do seem palpable indications in this direction. On the other hand, *Bathycolpodes subfuscata*, *Anisodes leonaria*, *Somatina nucleata*, *Cleora ansorgei* and *Chorodnodes rothi* are quite characteristically West African species, the last named being indeed the only member of its genus.

Subfam. **Oenochrominae.**

1. **Derambila macritibia,** Prout.

Seitz, Macrolep., xvi (in the press) (1927) (São Thomé).

24 Jan.–25 Feb., 2 ♂♂, 11 ♀♀.

Subfam. **Hemitheinae.**

2. **Pingasa decristata,** Warr.

Nov. Zool., ix, p. 492 (1902) (São Thomé).

24 Jan.–25 Feb., 1 ♂.

Probably represents the *ruginaria* group on São Thomé.

3. **Pingasa rhadamaria** (Guen.) **attenuans** (Walk.).

Hypochroma attenuans, Walk., List Lep. Ins., xxi, p. 430 (1860) (Sierra Leone).

24 Jan.–25 Feb., 1 ♀.

4. **Lophorrhachia omorrhoda,** Prout.

Seitz, Macrolep., xvi (in the press) (1927) (São Thomé).

10–24 Jan., 2 ♀♀; 24 Jan.–25 Feb., 1 ♀ (type).

5. **Bathycolpodes subfuscata** (Warr.) **subferrata,** Prout.

Seitz, Macrolep., xvi (in the press) (1927) (São Thomé).

10–24 Jan., 1 ♂; 24 Jan.–25 Feb., 2 ♂♂ (type).

6. **Thalassodes digressa** (Walk.).

Geometra digressa, Walk., List Lep. Ins., xxii, p. 513 (1861) (Natal).

10–24 Jan., 1 ♂, 1 ♀.

7. **Thalassodes unicolor,** Warr.(?).

Nov. Zool., ix, p. 497 (1902) (Nigeria).

24 Jan.–25 Feb., 1 ♀; Mar., 1 ♂.

Both worn, but seem to agree with Warren's species in size, shape, the pale fringe, etc. The whitish lines are indicated, though not strong.

8. **Comostolopsis fluorita,** sp. n. (Plate XX, fig. 1.)

♀, 20–22 mm.

Face brown above, whitish below. Palpus nearly 3, with 2nd and 3rd joints both long; brown-mixed above, white beneath. Crown green, very narrowly white in front. Antenna subserrate. Thorax and abdomen green above, white beneath.

Fore-wing with SC^1 anastomosing slightly with C, R^1 in one example connate, in the rest variably stalked; fluorite-green to bright turtle-green, when bred probably of the former hue; costal edge narrowly whitish, proximally more drab-grey; a very small dark-green cell-dot, commonly mixed with blackish scales; lines rather indistinct, whiter green; antemedian lunulate-dentate, rather oblique outward to fold, then more vertical; post-median about 2 mm. from termen, slightly incurved (but weakened) to costa, lunulate-dentate; fringe with a slender yellowish line at base, then green, paling off to whitish.—*Hind-wing* with the cell-dot generally mixed with black and red-brown scales; postmedian line and fringe as on fore-wing.

Underside whitish blue-green.

São Thomé, 24 Jan.–25 Feb. 1926, 8 ♀♀.

9. **Comostolopsis rubristicta** (Warr.).

Eucrostes rubristicta, Warr., Nov. Zool., vi, p. 23 (1899) (Uganda).

10–24 Jan., 1 ♂. Also from São Thomé in Mus. Tring.
A widely distributed species in West Africa.

Subfam. **STERRHINAE.**

10. **Traminda obversata** (Walk.).

Acidalia (?) *obversata*, Walk., List Lep. Ins., xxiii, p. 790 (1861) (Sierra Leone).

São Thomé, 1 ♀ in coll. Tring Mus.
Apparently found almost everywhere from Sierra Leone to Rhodesia.

11. **Anisodes leonaria** (Walk.).

Ephyra (?) *leonaria*, Walk., List Lep. Ins., xxii, p. 635 (1861) (Sierra Leone).

24 Jan.–25 Feb., 1 ♂.

12. **Somatina nucleata,** Warr.

Nov. Zool., xii, p. 390 (1905) (Sierra Leone).

10–24 Jan., 1 ♀.
Previously known from Sierra Leone, Gold Coast and Nigeria.

13. **Antitrygodes dentilinea,** Warr.

Nov. Zool., iv, p. 47 (1897) (Sierra Leone).

10–24 Jan., 1 ♂. Also 1 worn ♂ in coll. Tring Mus.
Distributed in West Africa and reappearing in Madagascar. The São Thomé specimens have the ground-colour rather deep purplish, the green blotches large (? racial).

14. **Scopula dux,** sp. n. (Plate XX, fig. 2.)

♀, 32 mm.

Head pale buff, upper $\frac{2}{3}$rd of face and entire outerside of palpus black. Thorax and abdomen concolorous with wings, the abdomen with black dorsal spots. Foreleg moderately infuscated, nearly black on front of coxa.

Fore-wing of moderate width, apex rather acute, termen oblique, gently curved, faintly waved; pinkish-buff, slightly suffused with cinnamon and with moderately strong black irroration; cell-dot black, rather strong; lines black, strongest as vein-spots, connected by fine incurved lunules; antemedian 4 mm. out at *SC*, rather oblique inward, the lunules faint; postmedian sharply angled outward at R^1, incurved between this and R^3 and very slightly posteriorly, quite as in *cervinata*, Warr. (Nov. Zool., xii, p. 389); median shade tinged with cinnamon, well beyond cell-dot, outbent at R^3, incurved at fold and dentate outward at SM^2, here slightly mixed with black proximally; pale subterminal indistinct, lunulate; terminal black dots strong, subtriangular; fringe with black dots at vein-ends.—*Hind-wing* with termen waved, not appreciably bent at R^3; markings, except 1st line, continued, a slight greyish line at proximal edge of median shade, curving inwards proximally to the cell-dot.

Underside much paler, a tinge browner than cartridge-buff; costa of fore-wing blackish proximally; cell-dots strong; a greyish median line indicated on fore-wing and very faintly on hind-wing; postmedian line strong, on hind-wing more distal than above; fore-wing with greyish suffusion in distal area, rendering visible the subterminal; terminal dots strong; fringes spotted.

São Thomé, 24 Jan.–25 Feb. 1926, type ♀; Sep.–Oct. 1926, 1 ♀.
In markings quite like a much overgrown *cervinata* (which may be a race of *improba*, Warr., Nov. Zool., vi, p. 293), but rather less broad-winged, rather darker.

15. **Scopula comes,** sp. n. (Plate XX, fig. 3.)

♂ ♀, 22–24 mm.

Face and palpus black above, whitish below. Vertex and front of thorax scarcely paler than fore-wing; collar more ochreous brown. Antennal ciliation in ♂ over 1. Thorax and abdomen concolorous with wings. Foreleg more or less infuscated on upper- and innerside; hind tibial pencils of ♂ rather strong, whitish, tarsus about $\frac{1}{4}$ tibia.

Fore-wing shaped and marked as in the *nesciaria* (Walk.) group; slightly yellower than tilleul-buff, the colour produced by more pinkish suffusions over a whitish-buff ground; fine scattered black irroration; base slightly clouded; cell-dot very small, black, on a small and slight cloud; antemedian line at slightly beyond $\frac{1}{4}$, never very strong or sharp, bent in cell; median broader, better expressed, from about $\frac{3}{5}$th costa to about middle of hind margin, angled outward on R^1, shallowly incurved between this and R^3 and rather more markedly between M^1 and SM^2; postmedian midway between median and termen, dentate, generally punctuated by black dots on the veins, roughly parallel with median, the inward bend between the radials rather deeper, the posterior one commencing at M^2; the shades which bound the sinuous pale subterminal moderate; termen with small but sharply black interneural dots; fringe with minute clusters of black irroration at vein-ends.—*Hind-wing* extremely weakly bent at R^3; proximal area unmarked; median shade incurved proximally to cell-dot and more slightly behind M; the rest nearly as on fore-wing, the postmedian rather more proximal, not or scarcely black-dotted.

Underside more whitish, the fore-wing (except posteriorly) a little suffused, the markings, except the antemedian, more or less well expressed, the hind-wing with only the cell-dot and generally the postmedian well expressed; terminal dots as above; fringes unmarked.

São Thomé, 10–24 Jan. 1926, 1 ♂ (type), 5 ♀♀; Sep.–Oct. 1926, 1 ♀. Also a long series in coll. Tring Mus.

16. **Sterrha insularum,** nom. n.

Ptychopoda rufulata, Warr., Nov. Zool., viii, p. 11 (1901) São Thomé) (nec *Pogonogya rufulata*, Warr., Nov. Zool., vii, 159 [1900]).

As Warren's *Pogonogya* is not generically separable from *Sterrha* (= *Ptychopoda*), a new name becomes necessary for the present species, which has also been sent from Principe by Mr. Barns.

Subfam. **Larentiinae.**

17. **Eois pyrauges,** sp. n. (Plate XX, fig. 4.)

♂ ♀, 24–27 mm.

Group of *grataria*, Walk., the antenna in the ♂ bearing very long pectinations, in the ♀ shorter ones (genus *Pseudasthena* of Moore). Head and body concolorous with wings; fillet clear yellow (not white as in *grataria*), antennal shaft mostly infuscated, its base orange or yellow.

Fore-wing with termen rather more oblique than in *grataria*, not appreciably bent at R^3; clear yellow, often sufficiently suffused with red to produce in parts a salmon-orange colour, clear yellow spots persisting between the red markings in distal area, those between R^1 and R^3 just outside the postmedian band rather large, more or less confluent; veins in places purple-red; numerous crenulate purple-red lines much as in the allies, the postmedian group with some clouding between, thus suggesting a band, which is rather well-defined proximally by a black-grey admixture in the first line, and a clear yellow or orange median area, the latter containing the rather large black cell-dot.—*Hind-wing* with termen rather

less sharply angled than in *grataria*; coloration as on fore-wing; scheme of markings as in the allies, basal area generally clear, the dark limiting line rather regularly curved, rarely intense.

Underside very much paler, pinkish-buff, with the principal lines of the upperside indistinctly marked in grey.

São Thomé, 10 Jan.–24 Jan. 1926, 3 ♂♂, 4 ♀♀.

One ♂ is an ab. rather less copiously lined, but with the postmedian band and its continuation on the hind-wing mixed with blackish, on the fore-wing with a longitudinal streak behind R^3 connecting it with termen, recalling some American *Eois*, such as *nigrinotata*, Warr. (Nov. Zool., xiv, p. 240), the hind-wing also with a dark midterminal spot.

18. **Xanthorhoë,** sp.

24 Jan.–25 Feb., 1 ♀.

Apparently near *trientata*, Warr. (Nov. Zool., viii, p. 210), but not fresh enough to describe, especially without the aid of the ♂ structure.

19. **Collix psephena,** sp. n. (Plate XX, fig. 5.)

♂, 35 mm.; ♀, 39–42 mm.

Much like a darker *foraminata*, Guen. (Spec. Gén. Lép., x, p. 358), underside with the markings a little narrower and weaker. Distinguished by having the ♂ midtibia scarcely dilated, the palpus appreciably less long. The darkest forms (3 ♀♀) show a very distinct, elongate, pale cinnamon-buff (proximally more pinkish) spot in cellule 3 of the fore-wing outside the median band on the fore-wing and a shorter, slightly paler one on the hind-wing, showing a close affinity with the little-known *inaequata*, Guen. (Maillard's Réunion, Annexe G, p. 35 = *flavipuncta*, Warr. 1901). This latter species, however—known to me in 2 examples—has also the highly dilated and grooved ♂ midtibia, the cell-spots of the fore-wing less large, the pale outer spots less long, brighter.

São Thomé, 24 Jan.–25 Feb. 1926, 1 ♂, 7 ♀♀.

20. **Eupithecia thomasina,** sp. n. (Plate XX, fig. 6.)

♂, 24 mm.; ♀, 25–26 mm.

Face whitish, suffused with drab; cone at lower edge very small. Palpus heavy, in the ♂ 1½, in the ♀ slightly longer, terminal joint short, concealed; whitish, mixed with drab and grey. Vertex dirty white. Antennal ciliation minute (¼ or less). Thorax and abdomen concolorous with wings, the abdomen dorsally marked with brown (in 1 ♀ with blackish-fuscous) proximally and distally. Foreleg infuscated above and on innerside, the ends of the joints whitish.

Wings shaped as in *dilucida*, Warr. (Nov. Zool., vi, p. 297 = *nigribasis*, Warr., Nov. Zool., ix, p. 511), or slightly broader; less glossy. *Fore-wing* with areole very long, undivided; white-grey with rather coarse fuscous irroration, which varies according to the individual, leaving white a small patch at termen behind R^3, a small bisected costal patch outside the median area, and either a great part of the median area or merely its outer half from costa to R^3; veins in median area sometimes in part with short white dashes; some rather bright brown suffusion at base and again between SC^5 and M^2 outside the median area, entering it in a streak behind R^3; an ill-defined dark band between basal patch and median area, angled outward in cell; postmedian rather thick from costa at about 7 mm., excurved between this and M^1, posteriorly more interrupted but with black dots on the veins; a shorter streak from costa between postmedian and subterminal; a wavy white

subterminal line indicated; terminal line very slight; fringe strongly chequered.—*Hind-wing* whitish, with slight drab suffusions and ill-defined smoky-drab border of about 2 mm. width; fringe chequered.

Both wings beneath more nearly as hind-wing above, the fore-wing the more smoky, the hind-wing showing a slightly bent postmedian line and some other fainter lines.

São Thomé, 24 Jan.–25 Feb. 1926, 1 ♂, 2 ♀♀.

The Tring Museum has ♀♀ from the Kikuyu Escarpment which appear to be a race of this.

21. **Chloroclystis catoglypta,** sp. n. (Plate XX, fig. 7.)

♂ ♀, 26–28 mm.

Face pale greenish-buff, narrowly black above; the small tuft at lower extremity black-mixed. Palpus just over $1\frac{1}{2}$, mottled with black. Vertex green. Antennal shaft blackish, the joints in ♂ slightly projecting, with fascicles of fine cilia, a little longer than diameter of shaft. Thorax above green, with paired blackish posterior tuft; beneath white. Abdomen above green with small black dorsal crests and a blackish dorsal belt near end, succeeded by a very slender white one; beneath white anteriorly, green posteriorly. Foreleg partly infuscated.

Fore-wing green, between citrine-drab and deep grape-green, with some fine dark irroration, which is sometimes strong in median area; markings blackish; cell-mark long, very oblique; a fine, faint, twice exangled subbasal line; an irregular, in places indistinct antemedian line, thickest at costa, oblique outward, forming teeth on *SC* and cell-fold quite near the cell-mark; irroration of central area tending to form rippled lines (in one ♂ suggesting a more solid dark band); postmedian at costa thick and oblique inward, then fine and crenulate, with a blunt lobe outward at radials; white subterminal dots, the first 4 very small, accompanied proximally by larger blackish spots, the 5th (in cellule 3) not minute, the rest very small and weak; terminal line fine, interrupted; fringe chequered with black.—*Hind-wing* concolorous, the scheme in general similar.

Underside very striking; both wings very pale yellowish-grey, suffused with smoke-grey; cell-marks present; a rather broad grey postmedian line, angled outward behind R^3, on fore-wing marked with a black costal spot; a very narrow black terminal band on each wing, 1 mm. wide at costa, tapering slightly to its end at R^3, cut by 4 pure white interneural lines; white interneural marks also posteriorly but less neat, and, on the pale ground, inconspicuous.

São Thomé, 24 Jan.–25 Feb. 1926, 3 ♂♂, 4 ♀♀.

22. **Chloroclystis desiderata,** sp. n. (Plate XX, fig. 8.)

♀, 25 mm.

Head green. Palpus $1\frac{3}{4}$, green, on outer side mixed with black. Thorax above green, in middle grey; beneath white-grey, at base of fore coxa green; abdomen dorsally green, laterally much mixed with black, ventrally pale; the crests mixed with black. Legs partly infuscated, at extremities of joints pale.

Fore-wing rather bright rainette-green, with a few scattered black dots on some of the veins; median area at costa and at hind margin red (ochre-red or deep Corinthian red), the costal patch continuing in proximally abbreviated, longitudinal streaks as far as R^3, the hind-marginal one not crossing SM^2; indications of fine dark lines in basal area; a very ill-defined band beyond (reaching the cell-mark), its anterior part, and more restrictedly its posterior, mixed with black, the intermediate part merely of a slightly darkened green, its average width 1·5 mm., its margins irregular; postmedian line crenulate and slightly sinuous, pale-edged distally, only sharply black where it borders the red patches; sub-

terminal fine, dentate, whitish, shaded with black proximally at costa and radials and more slenderly posteriorly, in cellule 3 interrupted by a conspicuous yellow-green longitudinal mark; terminal line black, slightly interrupted at veins; fringe dark, at base and beyond middle with pale lines, between these lines cut with green opposite the veins.—*Hind-wing* with proximal area blackish, median red, rippled with pale buff; postmedian line and all beyond as on fore-wing.

Underside grey with darker markings, recalling those of *rectangulata*, Linn.; the pale green subterminal streaks of cellule 3 indicated in dirty white.

São Thomé, 24 Jan.–25 Feb. 1926, 1 ♀.

23. **Chloroclystis consobrina** (Warr.).

Calluga consobrina, Warr., Nov. Zool., viii, p. 11 (1901) (São Thomé).

24. **Chloroclystis (Mesocolpia) subcomosa**, Warr.

Mesocolpia subcomosa, Warr., Nov. Zool., viii, p. 12 (1901) (São Thomé).

10–24 Jan., 1 ♂, 1 ♀.

25. **Gymnoscelis birivulata**, Warr.

Nov. Zool., ix, p. 509 (1902) (São Thomé).

26. **Gymnoscelis crassata**, Warr.

Nov. Zool., viii, p. 208 (1901) (São Thomé).

27. **Lobidiopteryx stulta**, Prout, **thomae**, subsp. n. (Plate XX, fig. 9.)

♂, 32–33 mm.; ♀, 36 mm.

Smaller than *L. s. stulta*, Prout (Bull. Hill Mus., 1 (1), p. 149, Belgian Congo). Abdominal tergites posteriorly with rather distinct white belts bearing paired black spots. *Fore-wing* with ground-colour whiter, less yellowish, standing out sharply almost without green irroration, against the lines; lines rather pale grey-green (perhaps tea-green to vetiver-green), the principal ones marked with black dashes or paired (partly subconfluent) dots on the veins, these black marks more or less strongly accompanied by some orange scales; admarginal vein-spots mixed with black.—*Hind-wing* slightly greyer (less yellowish) than in *s. stulta*, perhaps slightly smaller; the fine, darker grey postmedian line sometimes traceable.

São Thomé, 24 Jan.–25 Feb. 1926, 3 ♂♂, 1 ♀.

I am not at all certain that this may not prove a separate species, as the wings appear slightly less broad. It is much smaller than *veninotata*, Warr., the antemedian lines less oblique outward posteriorly, the veins less spotted, etc. "*Tephroclystia*" *atrospila*, Strand (Ent. Mitt., iv, p. 180, f. 6), seems evidently another related *Lobidiopteryx*, but cannot well be the same.

28. **Protosteira** (?) sp.

24 Jan.–25 Feb., 1 ♀.

A worn white long-winged species with grey markings, apparently agreeing in structure with the ♀ of "*Holorista*" *spectabilis*, Warr. (Nov. Zool., vi, p. 36), and not dissimilar in the markings.

Subfam. **GEOMETRINAE.**

29. **Cleora (?) ansorgei** (Warr.).

Nov. Zool., viii, p. 15 (1901) (Congo).

10–24 Jan., 1 ♂.

A rather large specimen, with cell-spot of fore-wing enlarged, postmedian line of both wings between M^2 and SM^2 somewhat incurved and thickened. Perhaps a race. Hitherto known from Nigeria, Cameroons, Congo and Uganda.

30. **Cleora indivisa,** sp. n. (Plate XX, fig. 10.)

♂, 51 mm.

Like *divisaria*, Walk. (List Lep. Ins., xxi, p. 366), which it evidently represents on São Thomé, but with the antenna longer, with about 42 joints pectinate, about 10 not, the pectinations themselves also longer.

Fore-wing with the median area concolorous with the proximal and distal, mottled with the same browns and greys as in the darker parts of *divisaria*; median costal spot (as in some *divisaria*) large and black; the fine black postmedian line rather less deeply angled outward at R^{1-2} than in *divisaria*; the clear cinnamon subterminal patch between (and just crossing) SC^5 and R^1 by far the most distinct marking.—*Hind-wing* rather darker than in average *divisaria*, becoming pale at abdominal margin.

Underside more heavily and suffusedly mottled with dark grey than in *divisaria*.

São Thomé, 10–24 Jan. 1926, 2 ♂♂.

31. **Cleora subcincta** (Warr.).

Chogada subcincta, Warr., Nov. Zool., viii, p. 16 (1901) (São Thomé).

10–24 Jan., 25 ♂♂, 13 ♀♀; 24 Jan.–25 Feb., 3 ♂♂, 4 ♀♀.

Extremely variable and interesting; most of the forms are parallel to those of its continental relative *tulbaghata*, Feld. (*acaciaria* auctt., *nec* Bdv.), but it cannot be called a race, as the antenna is rather longer, with considerably longer pectinations and a much shorter apical part simple.

32. **Cleora prosema,** sp. n. (Plate XX, fig. 11.)

♂ ♀, 36–40 mm.

Group of *tulbaghata*, Feld., but white, even less yellowish than *Ascotis reciprocaria*, Walk., the fuscous irroration sparse. Palpus mixed with fuscous on outer side. Antenna $\frac{3}{5}$th length of fore-wing; in ♂ pectinate to not quite $\frac{3}{5}$th, the pectinations of the proximal part long and lax. Fore and middle legs broadly banded with blackish-fuscous on upper and inner sides; hind tibia of ♂ dilated with hair-pencil, abdominal spine moderate.

Fore-wing with SC^1 and SC^2 free; cell-spot as in the *tulbaghata* group; median shade almost or quite obsolete except for costal maculation in front of cell-spot; no bright brown shades; antemedian line double, at costa and on SM^2 blackened and confluent; postmedian fine, little incurved behind middle; the shade beyond fuscous, only developed from costa to R^1; subterminal indicated chiefly by fuscous proximal spots at costa, between the radials and from M^1 hindward; a faint bluish apical suffusion; terminal black dots fairly large.—*Hind-wing* with cell-mark as in the allies; antemedian line single, fine and straightish (in the type obsolete), well proximal to cell-spot; postmedian accompanied distally by a fine and weak brownish line, which fades out at costa; subterminal spots reduced; terminals as on fore-wing.

Underside more recalling that of *Ascotis* than that of the allied species. Fore-wing with large cell-spot, a blackish apical patch to R^3 (leaving free the apex itself) and a weak subterminal extension thereof to beyond M^1. Hind-wing with small cell-spot. Both wings with terminal dots, the fringe of fore-wing anteriorly more strongly dark-spotted than above.

São Thomé, 10–24 Jan. 1926, 4 ♂♂, 1 ♀ (with type and allotype); 24 Jan.–25 Feb. 1926, 2 ♂♂; Sept.–Oct. 1926, 1 ♂.

Unlike some of its congeners, this species seems scarcely to vary at all. A note is attached to the last specimen that "the parasites on this moth are probably interesting," but I have no further information as to the parasites in question.

33. **Cleora albitrigonis,** sp. n. (Plate XX, fig. 13.)

♂, 42 mm.

Head and body concolorous with wings; palpus slightly blacker, about $1\frac{1}{2}$, 1st and 2nd joints with rather long hair, 3rd joint small, concealed. Face with very small cone below. Tongue fully developed. Antenna very little over $\frac{1}{2}$ length of fore-wing, with about 48 joints: the 1st fasciculate, 2nd with minute fasciculate pectination, 3rd to 38th or 39th pectinated with rather stiff branches, which at their maximum are about 5 times diameter of shaft. Hind femur slightly hairy, the others scarcely; hind tibia not dilated.

Fore-wing fairly broad, termen faintly waved, oblique; fovea small, but strong; $SC^{1,2}$ shortly stalked, SC^1 anastomosing at a point (1 example) or shortly (3) with C; black-brown, irrorated, strigulated and spotted with whitish-buff, the strigulation shown chiefly in median area costally; cell-mark elongate, black, very finely pale in middle; lines thick, vague, indicated in black, accompanied on their proximal sides by ill-defined pale shades; antemedian bifurcating at SC, joining again behind cell, thus enclosing a narrow pale mark in cell; postmedian zigzag, in an outward angle in cellule 5 enclosing a white spot more conspicuous than most of the others; a sinuous black median shade just beyond cell-mark; white dots on veins outside the postmedian; an irregular subterminal row of whitish spots, between the radials and at tornus small or obsolescent, in cellule 6 rather large; terminal line interrupted at veins; fringe with pale buff dots at veins.—*Hind-wing* rather full, crenulate, recalling the "*Racotis*" *squalida* group; cell-mark less elongate than on fore-wing, pale-pupilled; median shade proximal hereto; postmedian dentate, with white spots or dots on the veins distally, a very conspicuous subtriangular white spot proximally on radial fold; outer area as on fore-wing, fringe-dots conspicuous.

Underside more blurred, more inclining to olive-brown, darkest in distal area of fore-wing; whitish admixture slight, except between median and postmedian lines of fore-wing and in the region of the white triangle of hind-wing; indications of the subterminal, at least in cellule 3; fringe-dots present.

São Thomé, 10–24 Jan. 1926, 4 ♂♂.

34. **Cleora glaucotoxa,** sp. n. (Plate XX, fig. 12.)

♀, 50–55 mm.

Head pale olive-buff, more or less irrorated with black; a very slight black tuft in front of fillet; a small cone below. Palpus $1\frac{3}{4}$, with long projecting hair beneath, that of the 2nd joint projecting obliquely forward, 3rd joint small, concealed; black-mixed on outer side. Tongue fully developed. Antenna serrate. Thorax and abdomen above pale olive-buff to whitish, irrorated with black, the abdomen with large, but rather ill-defined, paired black spots; ovipositor generally extruded. Legs more or less banded.

Fore-wing with termen weakly subcrenulate; SC^1 and SC^2 both well free; very variable, white irrorated with buff and slightly or strongly with blackish-fuscous, which sometimes

overclouds most of the wing; subbasal black spots at costa and behind base of cell; lines glaucous-white, finely black-edged in median area; antemedian broad, from costa at 6 or 7 mm. to hind margin at 4 or 5, sinuous, angled inward behind *M*, dark-clouded proximally; postmedian finer, crenulate, more or less inbent between R^3 and M^2; a straighter stripe of more or less bright buff irroration midway between this and the subterminal; cell-spot large, glaucous-whitish, broadly crescentic but with a central projection, of irregular extent, on its distal (concave) side; a very irregular black median line, touching proximal side of cell-spot, incurved between this and M^2, strongly outbent in submedian interspace; subterminal whitish, deeply lunulate-dentate, filled in with blackish proximally and in places distally, crossed at R^3 by a longitudinal whitish streak, which reaches the fringe and the postmedian line, tapering proximally; termen with black lunular spots; fringe weakly chequered.—*Hind-wing* with costal margin fairly long, apex rounded, termen rounded, crenulate; whitish, irrorated (usually almost throughout) with fuscous; cell-mark crescentic, only distinct on the whitish form; postmedian and subterminal lines discernible, the former finely dark-edged proximally; termen and fringe as on fore-wing.

Both wings beneath whitish, irrorated and clouded with fuscous; cell-spots black, more or less crescentric, that of the fore-wing large; vague dark subterminal shades, preceded, at least on fore-wing, by an ill-defined pale stripe; fore-wing pale at apex and mid-termen.

São Thomé, 24 Jan.–25 Feb. 1926, 5 ♀♀.

35. **Racotis squalida** (Btlr.).

Ophthalmodes squalida, Btlr., A.M.N.H., (5) ii, p. 465 (1878) (Old Calabar).

24 Jan.–25 Feb., 1 ♀.

Rather small, more recalling *squalida voeltzkowii*, Pagenst. (1907), from Madagascar, than the name-typical West African form.

36. **Chorodnodes rothi,** Warr.

Nov. Zool., iv, p. 106 (1897) (Nigeria).

10–24 Jan., 1 ♀.

Previously known from Sierra Leone to Nigeria, and from the Upper Kassai District, Congo.

37. **Psilocerea gratiosa,** sp. n. (Plate XX, fig. 16.)

♂, 40–41 mm.; ♀, 42–44 mm.

Face and palpus orange. Antenna of ♂ pectinate to beyond $\frac{2}{3}$rd. Vertex, thorax above, front of pectus and most of abdomen above orange; end of abdomen and body beneath much paler. Abdomen beneath without basal spine; hind tibia in type with slender hair-pencil (of which no trace is findable in the one remaining hind leg of paratype).

Fore-wing with termen in ♂ not, in ♀ quite weakly angled at R^3; ochraceous-orange (♂) or somewhat duller (♀), a little more reddish costally; irrorated and (at least in the ♀) somewhat suffused with violet-grey; cell-dot minute, sharply black, with a few projecting whitish hair-scales distally; lines as in *pulverosa*, Warr. (1894), the distal scarcely approaching so closely to the apex, their colour red-brown, more or less edged with violet-grey.—*Hind-wing* with termen very feebly bent at R^3; concolorous with fore-wing, the postmedian line continued, central; slight indication of grey maculation generally discernible midway between this and termen.

Underside buff, with cell-dots, fine and faint postmedian line and sometimes traces of subterminal maculation of hind-wing; irroration quite sparse, grey or blackish.

São Thomé, 24 Jan.–25 Feb. 1926, type and paratype ♂♂ and allotype ♀; 10–24 Jan. 1926, paratype ♀.

38. **Luxiaria epinephela,** sp. n. (Plate XX, fig. 17.)

♂, **36 mm.**

Near *taeniata*, Warr. (Nov. Zool., iv, p. 109, Nigeria). *Fore-wing* more produced anteriorly, with termen faintly waved, straight, not convex, more recalling the shape of *amasa*, Butl. (Ann. Mag. Nat. Hist., (5) i, p. 405), though not quite so narrow; appreciably darker than *taeniata*; more tinged with avellaneous, the distal area more uniformly clouded with dull cinnamon-drab, the pale subterminal line indistinct.—*Hind-wing* with similar distinctions in colour.

Fore-wing beneath with the band between postmedian dots and subterminal line slightly broader than in normal *taeniata*, scarcely at all constricted in cellule 3; much clouding distally to the subterminal, especially in anterior half, where a broad, dentate line is suggested, thickened and darkened at costa and quite appreciable where it crosses the dark radial shading which the species shares with *taeniata*. Hind-wing much as in *taeniata*, the subterminal dark band less constricted in middle.

São Thomé, 24 Jan.–25 Feb. 1926, 1 ♂.

39. **Luxiaria lautipars,** sp. n. (Plate XX, fig. 18.)

♂, **30–33 mm.**; ♀, **36 mm.**

Face smooth. Palpus $1\frac{1}{2}$. Antenna of ♂ with long pectinations. Head and body concolorous with wings, the head and front of thorax a little darkened, the abdomen above with ill-defined pale spots and segmental bands.

Fore-wing with costa slightly arched proximally and beyond middle, apex moderately sharp but not produced, termen oblique, almost straight, scarcely waved; brown, inclining to cinnamon, with very slight pale mottlings and with fine black irroration; cell-dot moderate, black; lines fine, fuscous, only the postmedian sharp; antemedian excurved near costa, then very oblique inward to $\frac{1}{5}$th hind margin; median from a cloudy spot beyond midcosta, acutely angled outward at R^1, then very oblique inward to $\frac{2}{5}$th hind margin, very faintly incurved; postmedian slightly black-spotted on the veins, obsolete anteriorly, at R^1–R^3 about 2·5 mm. from termen, then more oblique than termen, behind M^2 very faintly incurved; subterminal crenulate, whitish buff; terminal dots black, strong, connected by a faint grey thread; fringe pale, with a dark dot at SC^5.—*Hind-wing* with termen scarcely waved, scarcely bent at R^3; cell in ♂ less than $\frac{1}{4}$, SC^2 arising close to base, very much curved, approaching successively C and R^1, R^1 nearly approaching R^3, the radial fold very close to R^3 near its origin, then more approaching R^1; proximal half whitish buff, with a small cell-dot closely followed by a fine line; distal half concolorous with fore-wing, with similar subterminal and terminal lines; the two areas separated by a strong black-mixed postmedian line, which is faintly waved, between M^2 and SM^2 slightly incurved, at abdominal margin oblique outward.

Underside pale, the fore-wing anteriorly and distally suffused with the brown of upperside and in part heavily irrorated with black; fore-wing with cell-dot rather strong, crossed by an incomplete blackish median line, postmedian punctiform, subterminal broadened into whitish lunules, with a dark shade proximally; hind-wing with only the minute cell-dot and curved line beyond distinct; postmedian dots weakly indicated; distal area almost vacant; terminal dots developed.

São Thomé, 10–24 Jan. 1926, 4 ♂♂, 1 ♀, including the type; 24 Jan.–25 Feb., 2 ♂♂.

On account of the pectinate antenna and contorted venation of the ♂,

Warren would probably have placed this species in *Idiotephra*, with the very differently shaped *curvivena*, Warr. (Nov. Zool., vi, p. 61). The structure is almost exactly that of my *Anoectomychus* (Nov. Zool., xxii, p. 339). I now regard that, however, as well as *Idiotephra*, as a mere ♂ section of *Luxiaria*. *Calletaera*, which has also pectinate antennae, lacks the frenulum, which is here fully developed.

40. **Syrrhodia albosignata** (Walk.).

Petrodava albosignata, Walk., List Lep. Ins., xxvi, p. 1656 (1862) [W. Africa].

10–24 Jan., 1 ♀; 24 Jan.–25 Feb., 1 ♂.

Both appear rather narrow-winged, produced apically; the ♀ is brightly coloured, especially beneath. Tring Museum has one São Thomé ♂, also aberrant, but not like Mr. Barns' except in being rather small, its borders beneath flushed with red.

41. **Melinoëssa molybdauges,** sp. n. (Plate XX, fig. 14, 15.)

♂, 41–44 mm.

Face grey, edged with buff. Palpus grey mixed with buff, on 1st joint paler. Antenna as in *palumbata*, Warr., or with the joints slightly more projecting. Head and body mouse-grey.

Fore-wing with apex produced, termen subconcave anteriorly, markedly gibbous at R^3; mouse-grey, darker than in the allies, with slight plumbeous reflections; costal edge paler, dark-dotted; cell-dot black; antemedian and postmedian dark-grey lines distinct posteriorly, fading out anteriorly, the antemedian a little outbent behind M, the postmedian more or less incurved between R^2 and SM^2, with a faint paler shade outside it, but with *no yellow marking*; subterminal spots placed as in *aemonia*, Swinh., blackish; terminal line weak; fringe pale.—*Hind-wing* with termen weakly subcrenulate, with a longer tooth at R^3; cell-spot, subterminal spots, terminal line and fringe as on fore-wing.

Underside similar, a little paler.

♀, 50 mm.

Shape nearly as in the ♂, fore-wing scarcely so prominent at R^3, hind-wing more strongly crenate, with a tooth at R^1, though smaller than that at R^3; ground-colour as in the ♂, but irrorated or mottled with yellow proximally and with an even more complete straw-yellow band outside the postmedian than in *aemonia*, broad and interrupted behind M^1, anteriorly forming an excurved row of interneural spots or lunules; some orange shading between this and the subterminal spots.

São Thomé, 10–24 Jan. 1926, 2 ♂♂; 24–25 Feb. 1926, 2 ♂♂, 1 ♀.

Near to *palumbata*, Warr. (Nov. Zool., i, p. 402), and *aemonia*, Swinh. (Tr. Ent. Soc. Lond., 1904, p. 498), probably nearer to the latter.

42. **Cabera (Thysanopyga) subalba,** Warr.

Nov. Zool., viii, p. 17 (1901) (São Thomé).

10–24 Jan., 7 ♂♂, 7 ♀♀; 24 Jan.–25 Feb., 4 ♂♂, 4 ♀♀.

Variable in size and in the upperside markings, fairly constant beneath. The commonest form has the cell-ring of the fore-wing small, black-pupilled; a modification of it (1 ♂, 1 ♀) has black cloudings over a great part of the fore-wing, leaving a pale brownish costal patch, rather recalling some South American Geometrids, such as *Bagodares*, etc.; another (1 ♀ only) is rather

pale, with a thick black terminal line; a further form (2 ♂♂, 1 ♀) has the white cell-spot large, blind. The last (1 ♂ only) has black pupil and black outline to the cell-spot and interrupted series of black spots proximally to the subterminal line, those in the anterior half of the fore-wing being heavy and confluent, succeeded distally by a second group.

43. **Xenostega latiscripta,** sp. n. (Plate XX, fig. 19.)

♀, 20–22 mm.

Head and body concolorous with wings.

Fore-wing slightly narrower (with termen more oblique posteriorly) than the continental species of the group—*fallax*, Warr., 1899, *diagramma*, Hmpsn., 1910, and *irrorata*, Prout, 1915—about as in *segmentaria*, Saalm., from Madagascar; the coloration also more as in this latter, duller and redder than in *fallax*, with the markings dark-grey, not ferruginous; 1st line crossing the cell-dot; 2nd thickened, faintly sinuous; the longitudinal line from this to termen very faint, ill-defined.—*Hind-wing* concolorous; 1st line crossing the cell-dot as in *segmentaria* and rare aberrations of *fallax*; 2nd strong or weak, in the type somewhat thickened.

Underside paler, hardly differing from strongly marked forms of *fallax*, except in the thicker postmedian; longitudinal mark of fore-wing well expressed, as well as the 1st line of both wings.

São Thomé, 10–24 Jan. 1926, 3 ♀♀, one being a fine aberration with the entire area between the lines filled in with the dark colour, bearing exactly the same relation to the type as *tyana*, Swinh. (1904), to *fallax*, making it evident that these two supposed species should be merged.

It is not unlikely that all the forms mentioned here represent a single very variable species, the two island races slightly narrower winged and less bright than the continental ones. In one of the *latiscripta*, R^2 of fore-wing is almost connate with R^1, as in my unique type of *irrorata*. In any case, Hampson's *diagramma* is pretty certainly a large form of *fallax*; Warren's type was mislaid at the time when Hampson's and my species were erected.

Addendum.

After this manuscript was completed, one additional São Thomé Geometrid, belonging to the Hemitheinae, was found in the Tring Museum:

7 *bis*. **Chlorissa albistrigulata** (Warr.).

Hemithea albistrigulata, Warr., Nov. Zool., iv, p. 39 (1897) ("South Africa").

It occurs almost everywhere in Africa and is doubtfully distinct from *faustinata*, Mill.

Explanation of Plate XX.

Fig. 1. *Comostolopsis fluorita*, Prout, sp. n. ♀.
2. *Scopula dux*, Prout, sp. n. ♀.
3. *Scopula comes*, Prout, sp. n. ♂.
4. *Eois pyrauges*, Prout, sp. n. ♂.
5. *Collix psephena*, Prout, sp. n. ♂.
6. *Eupithecia thomasina*, Prout, sp. n. ♂.
7. *Chloroclystis catoglypta*, Prout, sp. n. ♂.
8. *Chloroclystis desiderata*, Prout, sp. n. ♂.
9. *Lobidiopteryx stulta thomae*, Prout, subsp. n. ♂.
10. *Cleora indivisa*, Prout, sp. n. ♂.
11. *Cleora prosema*, Prout, sp. n. ♂.
12. *Cleora glaucotoxa*, Prout, sp. n. ♀.
13. *Cleora albitrigonis*, Prout, sp. n. ♂.
14, 15. *Melinoëssa molybdauges*, Prout, sp. n. ♂, ♀.
16. *Psilocerea gratiosa*, Prout, sp. n. ♂.
17. *Luxiaria epinephela*, Prout, sp. n. ♂.
18. *Luxiaria lautipars*, Prout, sp. n. ♂.
19. *Xenostega latiscripta*, Prout, sp. n. ♀.

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NEW GEOMETRIDAE FROM SÃO THOMÉ.

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A LIST OF *NOCTUIDAE* WITH DESCRIPTIONS OF NEW FORMS COLLECTED IN THE ISLAND OF SÃO THOMÉ BY T. A. BARNS

By Miss A. E. Prout.

[Read 6th April, 1927.]

Plate XXI and One Text-figure.

The specimens recorded in the following list were taken between January 10th and October, 1926; those obtained between 10th and 24th of January are marked "Edge of Virgin Forest." There seem to have been practically no previous records of Noctuidae from this Island.

All the type specimens here described, as in the case of the Geometridae in the preceding paper in this volume (pp. 187–200) are in the Hill Museum, Witley, Surrey, the collections having been made for Mr. J. J. Joicey.

Agrotinae.

1. Agrotis ipsilon.

Noctua ipsilon, Hufn., Berl. Mag., iii, p. 7 (1766) (Germany).

24 Jan.–25 Feb., 1 ♂, 1 ♀.

2. **Agrotis omochra,** sp. n. (Plate XXI, fig. 1.)

♂. Antenna with fasciculate cilia about or slightly more than length of shaft; segment 2 of palpus evenly scaled throughout, bay-coloured (Ridgway, pl. ii), tipped with warm buff (pl. xv), segment 3 warm buff weakly shaded with bay; head and patagia warm buff largely overlaid with bay; thorax and patagia bay with hardly any buff; abdomen above pale buff, slightly redder beneath; pectus and hair on femora predominantly chestnut; tibiae and tarsi buff shaded with bay or fuscous. *Fore-wing* warm buff washed with vinaceous-russet (pl. xxviii) and lightly irrorated with black, the buff persisting at base except on costa, but interrupted in fold by an irregularly dagger-shaped deep black mark with its point almost touching body; antemedial line buff bounding the pale area at costa, forming a distally convex lunule in fold, almost obsolete behind SM^2; orbicular and reniform buff with russet centres, the former round, the latter rather small, kidney-shaped, distally ill-defined; cell darkened (hardly black) between stigmata and more weakly so proximally to orbicular, a dark spot on distal edge of reniform; postmedial line black, crenulate, somewhat punctiform and ill-defined, bent outward from costa to $SC^{3,4}$, erect and well-removed from reniform to R^3, straight and oblique to near hind margin, distally toothed on SM^2; costa towards apex and termen somewhat darkened; no distinct terminal spots; fringe vinaceous-russet, slightly paler at base. *Hind-wing* cartridge-buff (pl. xxx), largely suffused with brownish-drab, especially towards termen; fringe pale, russet towards apex. *Underside* of fore-wing drab to near termen (deeper in cell), with slight dark bar on discocellulars, costa and termen tinged with russet, fringe russet; hind-wing somewhat as above but only darkened anteriorly to cell and R^1, where it is strongly tinged with russet; a drab discocellular point.

♀. *Fore-wing* more tinged with brownish-drab (pl. xlv) than in the ♂, with pale shades more overlaid; postmedial line better defined.

Expanse—♂, ♀, 36–37 mm.

24 Jan.–25 Feb., 7 ♂♂, 1 ♀.

Appears nearest to *A. atritegulata*, Hmpsn., Ann. S. Afr. Mus., ii, p. 26 (1902) (Transvaal), but hind-wing much more darkened. See also palpus.

HADENINAE.

3. **Polia deprivata,** sp. n.

Very near to *P. dipterigidia*, Hmpsn., Ann. S. Afr. Mus., ii, p. 267 (1902) (Cape Colony), of which it may possibly be no more than a local race, but differs in the following particulars: ground-colour of fore-wing more russet (pl. xv), without "yellowish" (*i.e.* buff) shades on inner area or pale patch at tornus; reniform much more distinct than in *dipterigidia*, buff shaded in centre with russet, the posterior end fuscous; orbicular a dark ring, claviform almost obsolete; lines double, dark, filled in with reddish-buff, subterminal pale, dentate, proximally dark-edged, with some distal dark streaks; hind-wing with proximal half almost white beneath, somewhat strongly darkened at and about apex, the postmedial line becoming obsolescent about middle of wing. Anal tuft in ♂ very large, buff.

Expanse—♂, ♀, 44 mm.

24 Jan.–25 Feb., 1 ♂, 1 ♀.

A worn ♀ from Ruwenzori in the Brit. Mus. Coll., placed under *dipterigidia*, may well be a race of *deprivata*, to which it seems nearer than to *dipterigidia*.

4. **Cirphis loreyi.**

Noctua loreyi, Dup., Lep. Fr., vii, p. 81, pl. 105, f. 7 (1827) (France).

10–24 Jan., 1 ♀; 24 Jan.–25 Feb., 1 ♀.

5. **Cirphis dialeuca,** Hmpsn.

Proc. Zool. Soc., 1910, p. 402, pl. xxxvi, f. 36 (N.E. Rhodesia).

24 Jan.–25 Feb., 1 ♂.

This may well be racially distinct, having the lines on the "tegulae" (*i.e.* patagia) weak and the dark line along *M* and R^3 broader than in typical *dialeuca*, more strongly defined by pale streak anteriorly than posteriorly, the fringe of fore-wing showing only one dark line (but imperfect). It has, however, seemed undesirable to erect a new subspecies upon a single ♂, especially in this obscure group. The secondary sexual characters of *dialeuca* are well-developed.

6. **Cirphis pyrausta,** Hmpsn.

A.M.N.H., (8) xii, p. 600 (1913) (Uganda).

10–24 Jan., 1 ♀; 24 Jan.–25 Feb., 2 ♂♂; Sept.–Oct., 1 ♂.

This again is probably racially distinct from the Uganda form, but there is too little material for a satisfactory comparison. The Mauritius specimens placed by Hampson under *C. nebulosa*, Hmpsn., appear to me to belong to this collective species rather than to *nebulosa*.

7. **Cirphis insulicola.**

Leucania insulicola, Guen., Spec. Gén. Lép., v, p. 82 (1852) (Madagascar).

10 Jan.–24 Feb., 1 ♂.

The type of this species is unknown to me.

ACRONYCTINAE.

8. **Stenopterygia firmivena,** sp. n. (Plate XXI, fig. 2.)

Section with R^2 of hind-wing almost fully developed.

Head, palpus, antenna, thorax and fore-wing cinnamon-brown (Ridgway, pl. xv) suffused with blackish, the cinnamon shade persisting chiefly on the palpus, head, tips of patagia, along centre of thorax and on distal half of fore-wing; abdomen above drab with the dorsal crests cinnamon-brown; body beneath paler drab, the hair on pectus and on fore-tibia more buff or cinnamon; tarsi banded (as usual). *Fore-wing* entirely clouded with blackish to medial line and reniform from costa to middle of cell, and (obliquely) from reniform to just before hind margin at hardly more than $\frac{1}{3}$, the inner lines almost entirely obliterated, the black shade continued, a little more weakly along fold to postmedial line; slight traces of double black bars on costa indicating origin of antemedial and medial lines; reniform slightly paler than ground-colour of wing, sub-triangular, narrowed above, proximally erect and distally oblique, dark-rimmed, slightly shaded with drab in centre; postmedial line double, with a double black bar at its origin, strongly bent outward just behind costa, obliquely dentate from $SC^{3,4}$ to R^2, strongly incurved behind R^3, but with pale teeth on the medials (especially M^2), bent outward to hind margin; subterminal slight, chiefly indicated by a slightly darker brown shade on its proximal edge and by the area beyond it being more purplish-drab, weakly waved, bowed outward from SC^4 to between R^2 and R^3, the purplish-drab shade running inward to the postmedial line at fold, with the subterminal very weakly indicated across it, apparently incurved; terminal spots almost linear, though thickened between veins; fringe cinnamon-brown shaded with drab. *Hind-wing* semi-hyaline, the termen (broadly except in fold), veins and discal spot shaded with fuscous. *Underside* of fore-wing nearly uniform fuscous except for four pale spots on costa towards apex; hind-wing nearly as above.

Expanse—29 mm.

10–24 Jan., 1 ♀.

All the African specimens of this genus which I have examined have R^2 of the hind-wing so strong that they might well be considered Ophiderids; but as they fit so well otherwise into this genus and as Hampson has included some African specimens under *subcurva*, Wlkr., Spec. Lep. Ins., xi, p. 592 (1857) (Ceylon), I have no hesitation in placing *firmivena* here until the generic difference between Indian and African species has been worked out.

9. **Parastichtis nigricostata,** Hmpsn., **gibbosa** subsp. n.

Differs from typical *nigricostata* (Cat. Lep. Phal., vii, p. 79, pl. cix, f. 22 (1908) (Sierra Leone)) in the shape of hind-wing, which is strongly bent, almost lobed at R^3, the costa being perceptibly shorter than in typical *nigricostata*. The hind-wing is darkened almost as in West African ♀♀; ♂♂ in the Joicey Collection from Gold Coast and Cameroons have the hind-wing white practically to the termen; the ♂ described by Hampson in Cat. Lep. Phal., from Mauritius, is therefore probably racially distinct. Dark terminal spots on hind-wing larger and more conspicuous than in typical form. The abdomen has a double, fine chestnut line down centre of *gibbosa,* which seems to be wanting in typical *nigricostata,* and the pale chestnut shades are more distinct on fore-wing and about apex of hind-wing beneath.

Expanse—♂, 47–51 mm.

10–24 Jan., 5 ♂♂; 24 Jan.–25 Feb., 2 ♂♂; Sept.–Oct., 1 ♂, 1 ♀.

10. **Trachea consummata.**

Hadena consummata, Wlkr., Spec. Lep. Ins., xi, p. 591 (1857) (Port Natal).

10–24 Jan., 3 ♀♀; 24 Jan.–25 Feb., 1 ♂, 2 ♀♀.

There are probably various races (perhaps distinct species) under this name, but until they are worked out it is useless to erect new races.

11. **Perigea africana,** Schs.

Lep. Sierra Leone, p. 33, pl. 2, f. 10 (1893) (S. Leone).

10–24 Jan., 2 ♀♀.

In these two ♀♀ there is a conspicuous white spot on subterminal line between R^3 and M^1, which is neither mentioned in the description nor shown in the figure in Cat. Lep. Phal., vii; the postmedial white spot on hind margin is also more conspicuous. These differences may probably be racial, but there is again insufficient material to establish a subspecies, especially in the absence of the type.

12. **Perigea capensis.**

Apamea capensis, Guen., Spec. Gén. Lép., v, p. 213 (1852) (Cape).

10–24 Jan., 1 ♂, 5 ♀♀; 24 Jan.–25 Feb., 2 ♀♀.

This common, widely distributed species seems to show little tendency towards racial variation.

13. **Conservula cinisigna,** de Joan.

Ann. Soc. Ent. Fr., 1906, p. 170, pl. 9, f. 2 (Mauritius).

10–24 Jan., 1 ♀.

This seems nearer to Mauritius ♂♂ and ♀♀ than to the Transvaal ♂♂ in the Brit. Mus. Coll.

14. **Eriopus maillardi,** Guen.

Maillard's Réunion, Lép., p. 39, pl. 22, f. 8 (1862) (Reunion).

10–24 Jan., 7 ♂♂, 6 ♀♀; 24 Jan.–25 Feb., 1 ♂, 1 ♀.

15. **Eriopus nigeriensis miosticta,** subsp. n.

Differs from typical *nigeriensis*, Hmpsn., Nov. Zool., xxv, p. 134 (1918) (S. Nigeria), in the rather larger average size and especially in the absence of white at apex and at termen on R^3; the white on subterminal line is very slender and at R^1 fades into a faint rufous shade, replacing the white on typical *nigeriensis*; the white dots on reniform are often obsolescent; the black patch in fold before antemedial line and the dark shade from costa between postmedial and subterminal lines are, on the other hand, rather stronger in subspecies *miosticta* than in the typical form. The terminal pale mark at R^2 is not even indicated by rufous on the underside. Altogether rather a more dusky-looking insect than typical *nigeriensis*, though about half the ♂♂ and one ♀ have an oblique white dash at posterior angle of cell; this dash is present in 3 out of 4 specimens of *nigeriensis* in the Joicey Collection, from Gold Coast.

Expanse—♂, 32–36 mm.; ♀, 32–34 mm.

10–24 Jan., 13 ♂♂, 3 ♀♀; 24 Jan.–25 Feb., 2 ♂♂.

Hampson's description of this species is rather misleading, as he not only describes it without any mention of the structure, but without mentioning that the ♂ antennae are wanting; by his number (3417[b]) he places it between *maillardi*, Guen., and *albomacula*, Leech, both of which have more or less thickening at middle of antenna. In reality *nigeriensis* shows practically no sign of any antennal thickening, but it possesses an apparently unique ♂ character of which Hampson makes no mention: *i.e.* a long, erect tuft of hairs from inner side of segment 2 of palpus, which, when in perfect condition, rises to well above the top of the head. The hind tarsus is tufted with hair to the end of segment 3, the mid tarsus on the first 2 segments; fore tarsus apparently without hair.

16. **Eriopus chera,** sp. n. (Plate XXI, fig. 3.)

♂ unknown. ♀.—Coloration nearly as in *nigeriensis*, from which it is at once distinguishable by the antemedial line, which is excurved throughout, not angled at SM^2, with the dark spots preceding it almost obsolete; differs also from *nigeriensis miosticta* in the following points: area between ante- and post-medial lines more uniformly tinged with bronze (darker than the pale shades in *miosticta*); white subapical teeth broader, more conspicuous; marginal lunules more sharply white-edged; terminal pale spot between R^2 and R^3 broad, white, conspicuous; pale bar at origin of postmedial line and spots beyond it on costa larger, whiter; the reniform has two obliquely-set anterior white spots and an oblique white streak at posterior end. *Underside* shows traces of the pale spot at angle of termen as well as the pale bar at origin of postmedial; postmedial line on hind-wing weak, slightly nearer the disc than in *miosticta*; size smaller.

Expanse—♀, 26 mm.

10–24 Jan., a single ♀.

In the absence of the ♂ the position in genus of *chera* must remain doubtful; but the species, though a typical *Eriopus*, appears to me almost certainly new to science.

17. **Eriopus nigrosticta,** sp. n. (Plate XXI, fig. 4.)

♂ unknown. ♀.—Thorax above and fore-wing verona brown (Ridgway, pl. xxix) irrorated with black and glossed with grey; markings indistinct, the most conspicuous being a row of semi-quadrate dark spots between the veins on anterior edge of the weakly pale subterminal line; these spots are weak in one ♀, practically obsolete in the type from costa to R^2; there are faint traces of the following dark markings; slight subbasal line, almost erect from costa to M, excurved in fold; this part of the wing is rubbed in both specimens and the line (very weak at best) may have been wrongly seen, but there is clearly a moderate-sized pure white spot in fold between the subbasal and the very weak, undulate, slightly excurved antemedial line, which runs from about $\frac{3}{8}$ costa to fully $\frac{2}{5}$ hind margin; postmedial line faintly double, the proximal line the stronger and submaculate, formed somewhat as in the two preceding species but more dentate throughout, more strongly oblique from R^2 to middle of fold; reniform indicated by a slight dark shade at each side, narrow, slightly oblique but almost straight; marginal dark spots slight, those behind R^1 and the medials slightly edged with white; the spot behind R^2 similarly edged in the second ♀; the pale spots on distal third of costa and the subterminal line very little paler than wing, the latter with a distally concave curve to R^1, behind which it is practically obsolete except for the proximal dark spots; fringe somewhat darker than wing, with fine pale line at base. *Hind-wing* whitish, tinged except at base with pale verona-brown and drab; rather well-defined dark terminal line and parallel line near base of fringe, which is buff at base, almost white at tips. *Underside* of fore-wing

pale brownish-drab except towards hind margin, the costa narrowly deep brown; fringe nearly as above; some pale buff at costa proximally forming small patches, distally mere dots, an oblique triangularly elongate bar at origin of the obsolete postmedial. Hind-wing paler than above with the following diffused brown markings; discal spot; crenulate postmedial line somewhat following the curves of wing; very obscure subterminal shade; marginal line and line on fringe as above, the latter blacker than the other markings. Pectus coloured somewhat as fore-wing beneath; legs shaded with verona-brown; abdomen above and beneath somewhat darker than the hind-wing.

Expanse—♀, 26–30 mm.

10–24 Jan., 1 ♀; 24 Jan.–25 Feb., ♀ type.

Notwithstanding the absence of the ♂ and the rubbed proximal area of fore-wing in both specimens, the very distinct coloration and unusual pattern above have made it seem safe to describe this species, which, by the shape, scale-tooth, pattern of hind-wing beneath, etc., seems an undoubted *Eriopus*.

18. **Craniophora adelphica,** sp. n.

Very near the Indo-Australian *C. fasciata*, Moore, Lep. Ceyl., iii, p. 5, pl. 144, f. 4 (1884) (Ceylon), from the typical form of which it differs in the rather larger size and richer colouring of fore-wing as well as in the much darker hind-wing. In the first two points it more nearly resembles *fasciata nigrostriata*, Pagens., from Amboina, but from this it is at once distinguishable by the complete interruption at middle of wing (between ante-medial and medial lines) of the black streak from base to before tornus; this break is more complete than in any *fasciata* form and the proximal end of the streak is somewhat weakened, not reaching costa at base of wing. Reniform more quadrate than in *fasciata*. The hind-wing is less noticeably flattened from R^1 to tornus than in *fasciata* ♂♂, and on the underside of both wings the markings are stronger (though more diffused), especially the postmedial line on fore-wing, which is strongly excurved from close to costa to posterior angle of cell, thence straight and erect. *Adelphica* also bears a good deal of resemblance to *C. paragrapha*, Fldr., Reis. Nov., pl. 100, f. 8 (1874) (Cape), which might well have been placed next to *fasciata* in Cat. Lep. Phal., viii. Unfortunately I have not seen either the type of *paragrapha* or a specimen from the Cape; but judging from figures in Felder's work and in the Brit. Mus. Coll., and from a specimen from Natal, the following differences appear to hold good. *Paragrapha* has the horizontal black streak more broken towards termen; medial dark shade hardly present behind the reniform (strong to hind margin in *adelphica*); hind-wing less strongly darkened (though darker than in *fasciata* ♂♂). The Natal specimen has the fore-wing slightly broader, more contrasted and sharply marked, with much more white on the lines; reniform kidney-shaped; the fringes are pure white chequered with brown, much more contrasted than in *adelphica*. All these differences (unless the shape of reniform) seem to be verified by Felder's figure.

Expanse—♂, 40–42 mm.

24 Jan.–25 Feb., 2 ♂♂.

19. **Prodenia litura.**

Noctua litura, Fabr., Syst. Ent., p. 601 (1775) (East India).

10–24 Jan., 1 ♂, 3 ♀♀; 24 Jan.–25 Feb., 4 ♂♂, 1 ♀.

20. **Athetis ignava.**

Caradrina ignava, Guen., Spec. Gén. Lép., v, p. 247 (1852) (Mauritius).

24 Jan.–25 Feb., 2 ♂♂. Too poor to identify with certainty.

21. **Phragmatiphila serrata** (?).

Phragmatiphila serrata, Hmpsn., Cat. Lep. Phal., ix, p. 268 (1910) (Uganda).

Sept.–Oct., 1 ♀.

In all probability this is a distinct species near to *serrata*, but as the ♀ of *serrata* is unknown and there is no ♂ from São Thomé, it has not seemed advisable to name the form. The reniform is hardly paler than the ground-colour and there are no distinct pale subterminal spots.

22. **Busseola ochrivirga,** sp. n. (Plate XXI, fig. 5.)

♂ antenna ciliate (Sect. ii of Hampson). Head whitish. General aspect and coloration somewhat as in *B. fusca* (*Sesamia fusca*, Hmpsn., Ann. S. Afr. Mus., ii, p. 296 (1902) (Cape)), but more uniformly warm buff in tone (Ridgway, pl. xv), almost without the rufous shades of *fusca*, though there are traces of fuscous clouding on anterior part of wing from the obsolescent antemedial line to near apex, reaching to behind *M* and origin of medials; this shade is stronger in the two larger ♂♂ than in the type; traces of dark subbasal spots at costa and on *M*; antemedial line very obscure and diffused, only discernible in the largest ♂, broadly excurved from $\frac{1}{3}$ costa to $\frac{2}{5}$ hind margin, but angled inwards behind costa, on *M* and on SM^2, strongly curved between the angles; postmedial line obscure, hardly visible except in type, apparently much as in *fusca* but rather more excurved at posterior angle of cell; stigmata almost obsolete, but all three specimens with an ochraceous-orange horizontal bar (pl. xv) from about $\frac{2}{3}$ cell to near termen (between R^1, R^2); a rather oblique row of blackish subterminal spots behind SC^5, R^1, R^2, R^3, with traces of spots behind M^1, M^2, the spot behind R^1 the largest; interneural terminal black spots weak, practically obsolete behind M^1. *Hind-wing* whitish tinged with buff, typically almost unmarked, in the two larger ♂♂ with weak traces of a diffused discal spot and shadowy curved postmedial line, excurved from costa to R^3, straight or slightly incurved to hind margin. *Underside* of fore-wing somewhat as above but rather paler, the markings weaker; hind-wing nearly as above. Body in all specimens discoloured with grease.

Expanse—♂, 26–33 mm.

10–24 Jan., 1 ♂ type; 24 Jan.–25 Feb., 2 ♂♂.

Notwithstanding considerable disparity in size and some discrepancies in markings—the latter probably due largely to somewhat imperfect condition—these three specimens almost certainly belong to the same species.

23. **Callyna figurans,** Wlkr., **thomae** subsp. n.

Differs from typical *figurans*, Spec. Lep. Ins., xv, p. 1667 (1858) (Natal), in the absence of the pale shading on and about *SC* from base to antemedial line, in the absence of dark shading distally to antemedial line from SM^2 to hind margin, and, especially, in the much reduced size of dark orbicular and claviform, the latter being reduced to a mere oblique streak edging the antemedial line. In subspecies *thomae* the pale edging to postmedial line is very slight on posterior half of wing, the dark line itself being also somewhat slighter and less crenulate; the dark shade from postmedial line to termen about R^2 is entirely wanting.

Expanse—♀, 40 mm.

24 Jan.–25 Feb., 1 ♀.

Elaeodopsis, gen. n.

Tongue aborted. Frons with a rather long, beak-like pointed prominence, about $\frac{1}{2}$ diameter of eye in length (measuring from eye), normally almost concealed by a thick

tuft of hair. Palpus slender; segment 1 short, with loose hair beneath; segment 2 with short hair in front, upturned, not reaching frontal prominence (less than diameter of eye); segment 3 quite short, stout, bluntly pointed. Thorax clothed with hair and narrow scales, without distinct crests. Abdomen apparently without crests. Pectus and legs (except tarsi) with rather long hair. *Fore-wing* rather narrow; costa straight; apex somewhat rounded; termen hardly crenulate; hind margin rather strongly down-curved on proximal half; cell about $\frac{3}{5}$ length of wing; SC^2, SC^3, SC^4, SC^5 all from extreme end of areole, or SC^3, SC^4 minutely stalked with SC^5; neuration otherwise normal. *Hind-wing* rather narrow, somewhat flattened from M^1 to tornus; cell about $\frac{1}{2}$ length of wing; neuration normal, but with R^2 rather unusually strong for a Trifid genus; separation after anastomosis rather sudden.

Text-fig. 1.—♂ Genitalia of *Elaeodopsis loxoscia*, gen. et sp. nov.

Type: *loxoscia*, sp. n.

We are indebted to Mr. W. H. T. Tams for the figure of the genitalia, of which he very kindly prepared a dissection for us.

24. **Elaeodopsis loxoscia**, sp. n. (Plate XXI, fig. 6.)

Head, thorax and fore-wing predominantly olive-yellow (Ridgway, pl. xxx); abdomen (apparently), hind-wing, body and wings beneath predominantly drab. *Fore-wing* clouded and irrorated with drab at proximal third (or fourth) of hind margin, triangularly from costa (at origin of subbasal line to middle of wing) almost to tornus and in a patch between postmedial and subterminal lines, from costa to R^1; a dark streak at base of costa; subbasal line represented by nearly straight dark bars behind costa and M at about $\frac{1}{6}$ wing, distally edged with white (especially the costal bar), the edge of clouding at hind margin probably indicating the distally oblique end of the line; antemedial somewhat oblique, from $\frac{3}{8}$ costa to nearly $\frac{1}{2}$ hind margin, composed of three very deep, distally convex loops (between costa and M, M and SM^2, SM^2 and hind-margin), angled inwards on M and

SM^2 almost to the subbasal, slightly white-edged on distal side, especially at costa; postmedial dark, dentate, from $\frac{5}{8}$ costa to hind margin near antemedial, strongly bent outward on SC^1 and curved to SC^5, the teeth on SC^5 to R^3 almost in line, bent inward behind R^3, but the tooth on SM^2 longer and broader than those on the medials, slight distal white edging, forming a distinct spot at costa; subterminal white, dentate, with slight proximal dark edging throughout, slightly bent inward opposite cell and in fold; fringe slightly chequered with drab at tips. *Hind-wing* paler (except at costa) from base to just beyond the diffused discal spot and with slight pale shade distally defining a diffused postmedial shade, the fringe chequered with whitish. *Underside* of fore-wing dark drab, pale (slightly greenish) at and near distal half of costa and termen, terminal line green, fringe whitish chequered with green; hind-wing paler than above, with dark irroration on proximal half of wing from costa into the cell; large, diffused discal spot, rather diffused postmedial line (nearly following curve of margin) and paler drab, diffused subterminal shade. The fore-wing is rather less elongate in the ♀ than in the ♂.

Expanse—♂, 34 mm.; ♀, 30 mm.

10–24 Jan., 1 ♀; 24 Jan.–25 Feb., 2 ♂♂.

Superficially this species recalls the genus *Elaeodes*,—from which it is at once separable by the glabrous eye and the position and comparative weakness of R^2 of hind-wing,—or *Trachea*, from which it differs in the aborted tongue, frontal prominence, etc.; but from these last two characters and from the grease on abdomen, which in one ♂ has spread all over the wings, I suspect it of an affinity with the reed-feeding group of genera (*Sesamia*, *Archanara*, etc.), which Hampson treats in vol. ix of Cat. Lep. Phal.

ERASTRIANAE.

25. **Eublemma apicimacula.**

Erastria apicimacula, Mab., C.R. Ent. Soc. Belg., xxiii, p. xviii (1880) (Madagascar).

10–24 Jan., 1 ♂.

26. **Cerynea ignealis.**

Cerynea ignealis, Hmpsn., Cat. Lep. Phal., x, p. 212 (1910) (Brit. E. Africa).

Sept.–Oct., 1 ♀.

Like No. 21, this is a single ♀ of a species described from a single ♂. A little redder on hind-wing; may well prove racially distinct.

27. **Amyna rubrirena poecila,** subsp. n.

The undescribed ♂ of *rubrirena*, Hmpsn., Nov. Zool., xxv, p. 181 (1918) (Cameroons), has a moderately large, round, conspicuous fovea in the cell of fore-wing. A series of a dozen ♂♂ and ♀♀ in the Joicey Collection from the type locality vary in size from 24 to 29 mm., the ♂ being on an average, but by no means always, a little smaller than the ♀, but they are extremely constant in pattern. In subspecies *poecila*, on the other hand, the single ♂ is noticeably smaller than any of the ♀♀, and there is great variability in the presence or absence of the subapical pale mark and in the colour of the reniform, the latter being darkened and inconspicuous in the ♂, edged with minute paler dots surrounded by a blackish line; in the ♀ it is either white, yellow or reddish, often without any traces of the edging of white dots found in all Cameroons specimens, or, if present, these dots are usually restricted to two at the posterior-distal edge; in the 4 ♀♀ in which the subapical pale mark occurs at all it takes the form of a comparatively narrow, erect yellowish bar from costa; the white spots on costa at origin of lines are usually quite inconspicuous—at most yellowish. Fringe of hind-wing apparently not edged with white at tips.

Expanse—♂, 26 mm.; ♀, 30–33 mm.

10–24 Jan., 1 ♂, 5 ♀♀; 24 Jan.–25 Feb., 3 ♀♀.

28. **Lithacodia blandula.**

Erastria blandula, Guen., Maillard's Réunion, Lép., p. 38 (1863) (Reunion).

10–24 Jan., 2 ♀♀; 24 Jan.–25 Feb., 1 ♂, 2 ♀♀.

EUTELINAE.

29. **Eutelia discistriga,** Wlkr.

Spec. Lep. Ins., xxxiii, p. 823 (1865) (Madras).

10–24 Jan., 1 ♀.

This species, occurring from West Africa to India and Ceylon, probably wants racial differentiation, but the single ♀ from São Thomé is of little assistance in such a work, which must therefore stand over.

30. **Chlumetia insularis,** sp. n. (Plate XXI, fig. 20.)

♂. Head, palpus and thorax pinkish-buff (Ridgway, pl. xxix), palpus and thorax largely shaded with bister (*l.c.*); abdomen above brownish-drab; pectus, legs and abdomen beneath predominantly pale pinkish-buff. *Fore-wing* with proximal half bister interrupted by paler lines, distal half pinkish-buff with bister lines and shades and a small patch of dull lavender (*l.c.*, pl. xliv) about middle of the radials, a slight lavender tinge here and there on other parts of wing; subbasal line diffused, sinuous, excurved, from costa to SM^2, forming a shallow proximal convexity from SC at about 2·5 mm. to hind margin at about 3 mm.; medial line oblique from costa at about 4 mm. to M^2 at 5·5 mm., proximally oblique to hind margin at 4 mm.; all these lines are pale with slight dark definition on each side and dark irroration, the distal dark outline of the medial forming the edge of the proximal dark area from M to hind margin, on costa the dark shade reaches almost to the inner postmedial, which is pale with slight dark line at proximal side and dark band between it and an outer postmedial, the inner line is excurved and a little sinuous from 6·5 mm. costa to hind margin at about 5·5 mm., the outer strongly excurved from origin of inner line at costa to M^1, where it again almost touches the inner line, excurved (almost angled in fold) to hind margin at nearly 8 mm.; an oblique pale shade (broadly diffused at middle) from 7·5 mm. costa to the subterminal line at about R^3, a deep bister, subtriangular spot between this shade and the subterminal at costa and a diffused, oblique dark streak on its proximal edge about the radials; these two dark shades and the lavender patch are the most outstanding features of this insect, together with the pure white reniform, which is narrow, erect, strongly constricted at middle, diffused and distally produced at anterior end, with black spot at middle of posterior half; subterminal line fine, pale, somewhat dentate, interrupted by a slight dark shade from about SC^5 to R^2 or R^3, nearly following line of termen but gradually approaching it towards tornus; a fine dark terminal line; fringe almost wanting. *Hind-wing* brownish-drab with slight postmedial and subterminal pale marks at tornus and on M^2, the subterminal mark on M^2 (which is close to termen) the most conspicuous. Fore-wing *beneath* pale brownish-drab, with postmedial white costal spot and two indistinct, maculate darker lines near termen; hind-wing whitish on inner third, with dark irroration on anterior and distal thirds, a dark discal lunule and four darkened lines, the inner postmedial strongly waved.

Expanse—25 mm.

Sept.–Oct., 1 ♀.

Probably nearest to *C. polymorpha*, Hmpsn., Nov. Zool., xxvi, p. 260 (1920) (Durban). Still nearer to two unnamed specimens in the Brit. Mus. Coll. from Ivory Coast.

STICTOPTERINAE.

31. **Stictoptera conturbata sanctae,** subsp. n.

Differs from typical *conturbata*, Wlkr., Proc. Nat. Hist. Soc. Glas., i, p. 354 (1869) (Congo), in the narrower dark border of the hind-wing, which leaves a much wider hyaline space between the border and the discal spot; postmedial line on fore-wing beneath much more strongly bent outward from costa than in the type of *conturbata*.

The ♂ and 2 ♀♀ have the area from base to medial line cream-buff (Ridgway, pl. xxx), in the other ♀ it is more washed with orange-cinnamon (*l.c.*, pl. xxix); the medial line is oblique; in the ♂ the outer half of wing is warm-sepia (*l.c.*) mixed with indigo, in the ♀♀ more or less smoke-grey (*l.c.*, pl. xlvi); all have a black spot on the pale area in fold, all but one ♀ a black bar as in Hampson's ab. *nigrilinea* of *signifera*, but much finer and with a slight spur below at middle.

Expanse—♂, ♀, 38–43 mm.

10–24 Jan., 1 ♀; 24 Jan.–25 Feb., 1 ♂, 2 ♀♀.

In Cat. Lep. Phal., xi, Hampson sinks *conturbata* to *signifera*, Wlkr., Spec. Lep. Ins., xiii, p. 1136 (1857) (Sarawak). *Conturbata* is unfortunately not before me in the Joicey Collections and is represented in the Brit. Mus. Coll. by 3 ♀♀ only; but Hampson is almost certainly in error here, there being no connecting-link known between W. Africa and the Andamans and Singapore with the exception of Madagascar specimens (*poecilosoma*, Saalm.), also sunk by Hampson to *signifera* but appearing to me abundantly distinct, with an even narrower border to hind-wing than in *conturbata sanctae* and, on the fore-wing, with the postmedial blue spots almost equally large and distinct from costa, instead of only behind R^2 (as in *signifera*), the medial line straighter; moreover, Madagascar specimens are distinctly larger than typical *signifera* and differ above all in the less elongate ♂ fore-wing. These differences are taken from a single ♂ and ♀ in the Joicey Collection, but they appear to be in the main supported by Saalmuller's figures of *peocilosoma*, *laetifica*, *semipartita*, *flavobasalis* and *subobliqua*, all apparently aberrations of a single species, which is probably distinct both from *conturbata* and *signifera*.

The single ♂ of *conturbata thomae* is nearer in shape to *signifera* ♂♂, but even that lacks the extremely arched costa, oblique termen and almost concave hind margin which distinguish *signifera* ♂♂ from all others in the genus.

32. **Stictoptera rhabdota,** sp. n. (Plate XXI, fig. 12.)

Palpus, head, thorax and fore-wing avellaneous (Ridgway, pl. xl) shaded with wood-brown (*l.c.*) and fuscous, intermixed with some chocolate along costa and *M* of wing. *Fore-wing* with proximal and distal areas unicolorous, with scarcely a trace of medial line; reniform slightly indicated by two narrow erect white bars, with slight dark bars on their inner edges and dark spots on the proximal and distal sides, the distal spot being the larger and more conspicuous; faint traces of indigo postmedial spots, somewhat as in *conturbata sanctae*; dark clouding from costa to cell, reaching from close to base almost to apex, the costa itself almost black throughout; a horizontal chocolate bar on SC^4 between the faint postmedial and subterminal lines much as in *conturbata sanctae* but slightly weaker; the area from *M* to middle of fold and between M^2 and R^4 deep chocolate to near termen, in the ♂ scarcely, in the ♀ slightly interrupted at the postmedial line; termen narrowly more violet-grey with dark streaks on the veins; terminal spots lunular; fringe avellaneous, crossed by two indigo-fuscous lines. *Hind-wing* nearly as in *conturbata sanctae*, but the

dark border rather narrower, especially in the ♂ (about $3\frac{1}{2}$ mm. in *rhabdota* ♂, nearly $4\frac{1}{2}$ mm. in *sanctae* ♂). *Underside* nearly as in *sanctae*, except for the narrower border of hind-wing.

Expanse—♂, ♀, 38 mm.

24 Jan.–25 Feb., 1 ♂, 1 ♀.

It is not impossible that *rhabdota* may prove to be no more than an aberration, or at most another race of *conturbata sanctae* (from a different elevation); but the fore-wing in both sexes appears slightly narrower though less elongate in *rhabdota* (the ♂ of *rhabdota* being shaped more as ♀ *sanctae*), and as the shape of wing and breadth of border of hind-wing seem the most reliable points of differentiation (apart from genitalia) in this very difficult genus, it has seemed best to regard *rhabdota* as a distinct species, placing it next to *conturbata*. The horizontal shade along middle of fore-wing certainly gives it a very distinct appearance.

33. **Lophoptera togata,** sp. n. (Plate XXI, fig. 11.)

Head and palpus blackish; thorax verona-brown (Ridgway, pl. xxix), the patagia crossed by a broad black bar, metathoracic crest large and conspicuous, slightly paler than the thorax; abdomen fuscous with some pale dorsal spots and segmental lines; pectus and legs more or less fuscous; abdomen beneath vinaceous-buff (*l.c.*, xl). *Fore-wing* purplish-black with a sharply defined pinkish-buff (*l.c.*, xxix), pale shade at base, its edge distally convex from base of costa to about $\frac{1}{4}$ hind margin, the proximal part being shaded with drab, leaving the clear buff only in a broad line against the black area; a slight rufous shade in and beyond the distal end of cell and a very slight hint of rufous between the veins here and there; stigmata almost entirely lost except for a white point at posterior angle of cell; antemedial line obsolescent, only discernible as an oblique reddish-black streak from middle of fold near middle of wing to hardly $\frac{2}{5}$ hind margin; medial, postmedial and subterminal lines represented by reddish-black spots on the veins (the subterminal weaker, less macular), nearly following the curve of termen but the medial and postmedial angled outward on SM^2; terminal spots black, semiquadrate; all these markings more or less indistinct on the dark ground; fringe fuscous. *Hind-wing* semi-hyaline with rather well-defined fuscous border, about $2\frac{1}{2}$ mm. round about R^1 and M^1, proximally produced before R^2 (to cell) and in fold; costa and hind margin fuscous; discal spot pale fuscous, diffused, shadowy; slightly blackish terminal spots; fringe fuscous tipped with white. *Underside* of fore-wing fuscous, semi-hyaline behind M and origin of M^1 to middle of fold; four pale buff spots on distal third of costa; hind-wing nearly as above; both wings with two oblique bars at costa near middle of wing.

Expanse—38–39 mm.

10–24 Jan., ♂-type; 24 Jan.–25 Feb., 1 ♂.

In the order followed in Cat. Lep. Phal., xi, this species may well be placed between *litigiosa*, Boisd., and *hemithyris*, Hmpsn.

Sarrothripinae.

34. **Giaura lia,** sp. n. (Plate XXI, fig. 9.)

Head and palpus tilleul-buff (Ridgway, pl. xl), the palpus shaded with brown; thorax pale vinaceous-drab (*l.c.*, pl. xlv); abdomen greyish-buff; pectus, legs and abdomen beneath tilleul-buff (very pale). *Fore-wing* tilleul-buff, distally tinged with pale vinaceous; a posteriorly convex dark line from base of costa to about $\frac{2}{7}$ of wing just behind costa, which it joins by a slight bar, with another, more deeply convex line behind it almost joined to it at the ends, the space between the two lines and costa before them irrorated

with cinnamon-drab (*l.c.*, pl. xlvi); these appear to represent the subbasal and antemedial lines, of which there is no other trace; a brown medial line from about $\frac{2}{5}$ costa, oblique and somewhat waved to middle of fold, much weaker and angled inward at SM^2; postmedial line brown, slender, crenulate, from costa near medial line, oblique to SC^5, incurved behind R^4 to middle of fold, where it is connected by a dark bar with the medial line, angled outward at SM^2; traces of a crenulate brownish subterminal line, incurved opposite cell; a broad, oblique fuscous shade from apex to the postmedial line at about SC^5–R^2; the semi-triangular area between this shade, the costa, the medial line and the black bar connecting the lines almost entirely filled-in with cinnamon-drab irroration; terminal spots blackish, almost connected but broadening between the veins; fringe pale buff. *Hind-wing* pale fuscous-drab, slightly paler at base; fringe paler but with a slight dark shade at middle. *Underside* pale fuscous-drab, the hind-wing whiter than above, fore-wing with costa buff with 3 or 4 oblique dark streaks crossing the distal third.

Expanse—♀, 23 mm.

24 Jan.–25 Feb., 1 ♀.

This pretty, somewhat glossy little insect is, by the structure, unmistakably a *Giaura*. Perhaps nearest to *lichenosa*, Hmpsn., Moths Ind., iv, p. 527 (1896) (Khasias).

Epigiaura, gen. n.

Tongue normal. Palpus with segment 1 tolerably hairy, about $\frac{1}{2}$ eye; segment 2 upcurved almost against face, shortly hairy in front and with small tuft behind; segment 3 short, pointed at tip, porrect, slightly thickened but hardly tufted; face apparently smooth, scaled; thorax clothed chiefly with scales, without distinct crests; abdomen with slight crest on first segment. *Fore-wing* with costa somewhat arched at base, apex slightly produced; termen non-crenulate, almost erect from behind apex to M^1, thence more incurved; cell about $\frac{4}{7}$; areole long and narrow, with SC^2 from near middle; SC^3, SC^4, SC^5 from end, SC^3, SC^4 stalked to just over $\frac{1}{2}$ from cell; other veins about normal. *Hind-wing* with the termen slightly incurved opposite cell, flattened behind M^2 (especially in ♂); hind margin strongly down-curved at base, almost with a scale-tooth; cell nearly $\frac{1}{2}$; R^3, M^1 stalked to well over $\frac{1}{4}$; other veins normal.

Type: *trachylepis*, sp. n.

35. **Epigiaura trachylepis,** sp. n. (Plate XXI, fig. 10.)

♂ antenna with minute ciliation. Head, palpus, thorax and fore-wing pinkish-buff (Ridgway, pl. xxix) irrorated with fuscous; abdomen above dark-drab, ♂ with anal tuft buff; pectus, legs and abdomen beneath very pale buff. *Fore-wing* with the lines (except subterminal) cadmium-yellow (*l.c.*, pl. iii) irrorated with fuscous, the subbasal distally convex from costa near base to M, with a slight mark near base behind SM^2; antemedial oblique from $\frac{1}{3}$ costa to fully $\frac{1}{2}$ hind margin, angled outward on SC and M, proximally convex in cell and almost angled in fold; postmedial bent outward from behind middle of costa, angled outward on SC and M and inward between, deeply convex proximally in fold; the ante- and post-medial lines weakly pale-edged, the former proximally, the latter distally; discal lunule brown, strongly curved and slightly oblique; a fuscous subterminal shade, angled inward at SC and (more weakly) at M, bent outward behind SC and (weakly) behind M; dark spots on the fringe behind SC^4 and SC^5 (the latter weak) and a lunular dark mark on the termen from behind SC^4 to behind M^1; this mark is weak in the ♀; terminal spots small, black; fringe buff faintly chequered with pale drab. *Hind-wing* pale drab only a little paler at base; fringe pale buff with drab shade at middle. *Underside* very nearly as in *Giaura lia* (No. 34), but with the dark spots on fringe of fore-wing present as above.

Expanse—♂, ♀, 26–27 mm.

10–24 Jan., 1 ♂, 1 ♀.

The position of this genus is not quite certain, but it appears to be nearly related to *Giaura*, from which it differs in the short third segment of palpus, position of vein SC^2, more elongate ♂ body with longer anal tuft, more produced apex of fore-wing. *Trachylepis* slightly recalls the Indo-Australian *Giaura punctata*, Lucas.

Elesmoides, gen. n.

Tongue normal. Palpus with segment 1 moderately hairy, about $\frac{1}{2}$ eye, segment 2 obliquely upcurved, fully $1\frac{1}{2}$ diameter of eye, moderately well scaled in front and on distal half (especially at tip) behind; segment 3 hardly $\frac{1}{3}$ length of 2, practically glabrous, bluntly pointed; antenna with a porrect tuft from front of basal segment, longer than breadth of shaft; face apparently without prominence, weakly scaled but with thick tuft above; thorax clothed chiefly with narrow scales, one or two specimens showing a dense erect crest on prothorax; abdomen with a small dorsal crest on first segment. Legs fairly normal, mid and hind tibia more strongly hairy in the ♂ than in ♀♀. *Fore-wing* long and narrow, with costa somewhat flattened; apex and termen moderately rounded, the latter weakly crenulate; cell nearly $\frac{3}{5}$; SC^2 free, given off much nearer to SC^1 than to SC^3, SC^4, SC^5, nearly meeting SC^1 at about $\frac{1}{3}$ or $\frac{1}{4}$ from cell; SC^3, SC^4, SC^5 stalked, SC^5 to roughly $\frac{1}{3}$, SC^3, SC^4 to beyond $\frac{1}{2}$; M^1 from well behind angle; other veins normal. *Hind-wing* cell fully $\frac{2}{5}$; anastomosis to near middle of cell; R^2 from barely $\frac{2}{3}$ discocellulars; R^3, M^1 very shortly stalked; other veins normal.

Type: *thomae*, sp. n.

36. **Elesmoides thomae,** sp. n. (Plate XXI, fig. 22.)

♂ antenna with long curved bristles and short, even ciliation; ♀ with shorter bristles and minute ciliation. ♀ head and patagia pinkish-buff (Ridgway, pl. xxix); palpus and thorax (♂ and ♀) and ♂ head and patagia bone-brown (*l.c.*, pl. xl); abdomen pale drab, with ♂ tuft more buff; pectus, legs and abdomen beneath predominantly buff, with fore and mid tibia blacker. *Fore-wing* bone-brown in ♀, in ♂ pinkish-buff, clouded on anterior half, at base and beyond postmedial line with pale bone-brown, one ♀ appears more buff than the rest, but it is worn; orbicular and reniform in ♂ oval black spots (appearing almost raised), the former horizontal, the latter vertical; one ♀ has similar but smaller spots, the others have the stigmata pale, the orbicular with black central dot, reniform with dark distal line; lines very indistinct, antemedial distally convex in cell and concave in fold; medial and postmedial somewhat similarly curved, but erect to *SC*, all faintly pale with dark outline; subterminal indicated by pale dots between the veins and, in the ♂, by some proximal wedge-shaped dark marks between veins SC^4 and R^3; terminal black spots wedge-shaped, proximally pale-tipped, varying in size; fringe bone-brown with pale dots at base and slight pale streaks. *Hind-wing* pale drab, paler and more buff on proximal half; fringe pale buff chequered with drab. *Underside* somewhat as in the last two species, but fore-wing with a faint discal dot and diffused postmedial line, strongly excurved round cell; hind-wing with a discal lunule and diffused, waved, curved postmedial line; termen and fringe much as above.

Expanse—♂, ♀, 39–41 mm.

10–24 Jan., 1 ♂; 24 Jan.–25 Feb., 7 ♀♀.

The placing of this species has been extremely difficult. The ♂ retinaculum hardly appears bar-shaped; but there are slight indications on one wing of what might have been a bar, and as in the genus *Gadirtha* the bar is exceedingly slender and often breaks away, it seems probable that the same

may have happened with this single ♂. In any case the species looks far more like a Sarrothripid than an Ophiderid, and the Arctiid-like anastomosis and very unusual subcostals fit better into this very dubiously Noctuid subfamily than into any more typically Noctuid group. On account of the exceptional neuration I place it next to the Australian genus *Elesma*, to which it falls by the key to SARROTHRIPINAE in Cat. Lep. Phal., xi, but from the diagnosis of which it differs in the presence of tuft at base of antenna; much shorter frontal tuft; absent (or very slight) metathoracic crest; presence of abdominal crest; shorter stalking of R^3, M^1 of hind-wing. Neither the description nor figure of *Elesma* suggests the exceptionally close proximity of SC^1, SC^2 found in *Elesmoides*.

ACONTIANAE.

37. **Microsada subrosea,** sp. n. (Plate XXI, fig. 15.)

Differs from *anaemica*, Hmpsn., Cat. Lep. Phal., xi, p. 580 (1912) (Gold Coast), in the following particulars. In *subrosea* the termen of fore-wing is more flattened (almost excised from apex to R^3); fringe darker, except on hind-wing from M^2 to tornus; fore-wing with a rather large ochraceous-orange (Ridgway, pl. xv) spot on distal side of discal lunule; hind-wing without black terminal points. In the type of *anaemica* the hind-wing is almost white; in some aberrations the wing is shaded anteriorly and distally with flesh-ochre (*l.c.*, pl. xiv); but the red shading is deeper, more Etruscan-red (*l.c.*, pl. xxvii) in *subrosea*; this colour is repeated beneath on the fore-wing and also in a broad clouding at apex of hind-wing which is almost entirely wanting in all specimens of *anaemica* as yet examined; the pale spots on termen of fore-wing beneath are weaker than in *anaemica*, except the spot between SC^4, SC^5; in *subrosea* the antemedial line is angled outward on *SC*, *M* and SM^2, inward between these points; green shade on fore-wing almost confined to costa, to the area between postmedial and subterminal lines and to a slight shade at hind margin. Long, narrow areole present, as in S. Nigerian specimen mentioned in Cat. Lep. Phal., xi. This is also present in 2 ♂♂ from Cameroons in the Joicey Collection. Unless Hampson has mistaken the venation of the type (which is unfortunately not before me), there are probably two distinct species here—one with white hind-wing and without areole, the other with areole and with hind-wing suffused with flesh-ochre. The latter may possibly be a race of *subrosea*.

Expanse—♂, 21 mm.

10–24 Jan., 1 ♂.

38. **Negeta cyrtogramma,** sp. n. (Plate XXI, fig. 7.)

♂ antenna with moderate ciliation—a little longer than diameter of shaft. Head and thorax cinnamon to sayal-brown (Ridgway, pl. xxix); abdomen drab tinged with cinnamon; pectus, legs and abdomen beneath paler, more buff, except anus of abdomen in ♀, which is blackish; anal tuft in 1 ♂ extruding some white hair. *Fore-wing* in ♂ typically vinaceous-pink (*l.c.*, pl. xxviii) on proximal and distal thirds, the latter clouded with brown at termen, in the other ♂ these areas are more tinged with vinaceous-lilac (*l.c.*, pl. xliv), the area between ante- and post-medial lines cinnamon-brown (*l.c.*, pl. xv), deeper and much more contrasted in the type than in the other ♂; ♀ fore-wing almost uniform cinnamon to Mikado-brown (*l.c.*, pl. xxix) except for slight dark clouding at termen; lines typically white with slight dark border; in all other specimens black, sometimes with faint traces of a pale edging, the antemedial oblique from scarcely $\frac{1}{3}$ costa to about $\frac{1}{2}$ hind margin, very weakly proximally convex; postmedial nearly following the curve of termen, but slightly more excurved round cell, from just beyond $\frac{2}{3}$ costa to not quite $\frac{2}{3}$ hind margin; subterminal represented by an indistinct row of black spots following curve

of termen, usually a little less obscure in ♀ than in ♂; cell spot represented by a white dot at posterior and a black point at anterior angle; fringe darker than wing, with a slight pale line at base. *Hind-wing* fuscous-brown, the fringe cinnamon-buff (*l.c.*, pl. xxix) at base and tips, broadly pale fuscous-brown at middle. *Underside* dull cinnamon, the fore-wing clouded with fuscous-brown except the usual pale area behind SM^2 and a narrow edge along costa and termen and a broader patch at apex (narrowing gradually to R^3), where the cinnamon persists; hind-wing more or less shaded with drab on proximal and posterior thirds, the shade on the latter narrowing to tornus.

Expanse—♂, 28–32 mm.; ♀ 33–34 mm.

10–24 Jan., 2 ♂♂, 4 ♀♀; 24 Jan.–25 Feb., 1 ♀.

This species appears close to *approximans*, Hmpsn., Cat. Lep. Phal., xi, p. 625 (1912) (S. Nigeria), but the postmedial line is much more strongly curved in *crytogramma*. Also apparently related to *Metaleptina geminastra*, Hmpsn., A.M.N.H., (7) xvi, p. 592 (1905) (S. Nigeria), but in *geminastra* the postmedial line is more incurved before the hind margin. This section of *Metaleptina* appears to me to belong to the *approximans* group of *Negeta*, the difference of areole upon which Hampson divides the genera being in this instance so slight and apparently subject to slight variation even within the same species as to be an unsafe guide, and the general facies being extremely similar. In *crytogramma* SC^2 is given off at end of areole, with stalk of SC^3, SC^4; SC^5 from well before end. This (normal) *Negeta* neuration may very easily become the short stalking of SC^2 found in *Metaleptina*.

Catocalinae.

39. **Nyctipao walkeri.**

Patula walkeri, Btlr., A.M.N.H., (4) xvi, p. 406 (1875) (Natal).

March, 2 ♂♂.

This widely distributed species shows a tendency to racial variation in the lines of the hind-wing. In the 2 São Thomé ♂♂ the medial line is very straight, the postmedial distally convex between R^3 and M^1, M^1 and M^2, M^2 and SM^2.

40. **Tolna atrigona,** sp. n.

Very near *complicata*, Btlr., A.M.N.H., (5) v, p. 389 (1880) (Madagascar), of which it may be merely a local race, but differs in the following particulars. In *atrigona* the reniform is considerably smaller and is differently shaped, being oblique from anterior angle of cell to a point just before R^2, instead of flattened along R^1 with the distal point *well* before R^2; instead of being darkened on proximal $\frac{1}{3}$ and between postmedial and subterminal lines (as in *complicata*), the fore-wing is distinctly darkened between the ante- and postmedial lines and the white markings are greatly reduced. Hind-wing rather more uniformly darkened, with postmedial line obsolescent and the subterminal white markings absent; fringe apparently more evenly chequered (worn). Rather less contrasted beneath than *complicata*; hind-wing with the lines rather more curved, the subterminal much nearer termen (more remote from postmedial), the border of wings uniformly pale greyish-buff.

Expanse—♀, 56 mm.

10–24 Jan., 2 ♀♀.

Although neither specimen is in perfect condition, the above diagnosis, together with the island locality, should make *atrigona* easily identifiable. It appears generally a little greyer in tone than *complicata*.

41. **Ercheia subsignata.**

Achaea subsignata, Wlkr., Spec. Lep. Ins., xxxiii, p. 959 (1865) (Sierra Leone).

10–24 Jan., 1 ♀; 24 Jan.–25 Feb., 1 ♀.

There may well be a number of species mixed under this name. Both specimens are large, almost without white on fringe of hind-wing.

42. **Achaea mormoides,** Wlkr.

Spec. Lep. Ins., xiv, p. 1393 (1858) (Natal).

10–24 Jan., 1 ♀.

This species again shows a good deal of variation—especially in the size of the white patch at apex of hind-wing. In the São Thomé ♀ this reaches practically to R^1.

43. **Achaea ezea thomensis,** subsp. n.

Differs from normal *ezea*, Cr., Pap. Exot., iii, p. 78, pl. 239 f. *D.* (1779) (Guinea Coast) in having the yellow patch on termen of hind-wing above slightly deeper in tone and but little broadened at apex, of nearly uniform breadth from SC^5 to R^2, behind which it tapers to a point, and in the presence of yellow dots on M^2 and SM^2, the former near termen, the latter almost at termen; these spots are usually slighter in typical *ezea*. On the fore-wing beneath the yellow band is quite narrow (about 2 mm.), only broadening behind M^2; in *ezea ezea* this band is normally about 4 mm. broad. The narrowing of the yellow markings does occur aberrationally in specimens from the mainland, and very occasionally it is found above and beneath in the same specimen, though much more rarely beneath than above; but as it is obviously quite aberrational on the mainland, whereas the seven São Thomé ♂♂ agree almost perfectly in both particulars, it has seemed advisable to regard the form as "var. et ab." and to give the São Thomé race a distinct name; especially so as it appears slightly more bent at R^2 of the hind-wing, the wing being slightly more elongate to this point than in normal *ezea*. From Cramer's figure it would appear that the type of *ezea* has the yellow band on hind-wing above somewhat narrower than the normal, though in the absence of the type itself it is impossible to speak with certainty, the figure being obviously inaccurate in several particulars.

Expanse—♂, 54–59 mm.

10–24 Jan., 4 ♂♂; 24 Jan.–25 Feb., 2 ♂♂; March, 1 ♂.

44. **Achaea indicabilis,** Wlkr.

Spec. Lep. Ins., xiv, p. 1394 (1858) (Sierra Leone).

10–24 Jan., 1 ♂.

45. **Achaea flexuosa,** sp. n.

♀. Head and thorax snuff-brown (Ridgway, pl. xxix), glossed with pale chestnut-brown (pl. xiv.); abdomen greyer, with two or three strong snuff-brown crests. *Fore-wing* hazel (*l.c.*) at base and between outer postmedial and subterminal lines, pale chestnut-brown (*l.c.*) to near inner postmedial line, the hazel and chestnut blending together round the antemedial line; a pale greenish-buff shade round about the inner postmedial line, termen buff strongly irrorated with chestnut, leaving strong interneural white spots before the waved black terminal line, the spot at middle of fold fully twice the size of the others; lines indistinct, blackish; subbasal showing faintly as an oblique pale streak from costa at about 2 mm.; similar antemedial and medial pale streaks from costa at about 7 and 9 mm.,

both with traces on each side of a dark outline, the antemedial continued across the wing as scattered, dark chestnut irroration, forming a slight, waved (double?) line to about 8·5 mm. hind margin, the medial obsolescent behind costa; two postmedial pale spots on costa, the proximal one distally dark-edged, at about 18·5 mm., the distal proximally dark-edged, at about 21·5 mm., the proximal line forming cuneiform black spots on the veins, connected by slight brown distally convex lunules, the spots distally oblique from R^1 to R^3, proximately so from R^3 to M^2 and slightly oblique distad from M^2 to SM^2; the outer postmedial obsolescent behind costa, defined only by some dark irroration, apparently following the course of the inner line, on one wing showing some slight spots between the veins; a faint dark spot in cell about the antemedial line; reniform obliquely kidney-shaped, rather narrow, slightly darker than wing, defined by dark irroration and with four pale dots at extremities, its anterior end about 12·5 mm., its posterior about 13·5 from base; subterminal line blackish, diffused, highly sinuous, obsolescent to behind SC^4 (where the hazel shade extends to termen), thickened and bent outward at R^1, incurved from R^1 to behind R^2, slightly incurved from behind R^2 to behind R^3, obliquely incurved from behind R^3 to behind M^1, deeply incurved from behind M^1 to middle of fold; fringe buff, with blackish strigulae at tips and forming a line at middle; conspicuous buff spots at the veins, slightly interrupting the terminal line. *Hind-wing* dark brownish-drab, the apex broadly light-orange yellow (pl. iii), about 7·5 mm. broad on C, 5 on SC^5, 2·5 on R^1, continued narrowly along costa to near base of wing, interrupted behind R^1 and largely obliterated by dark irroration behind this point; some tawny shading in distal $\frac{1}{3}$ of fold; a slight dark medial (?) shade from R^1 at about 14 mm. to middle of fold at about 19 mm. *Underside* of both wings buff strongly irrorated with brownish-drab, the fore-wing with a clear buff patch beyond middle, from about SC^5 to M^2; both wings with termen very pale buff from costa to behind R^1 and small pale mark at tornus.

Expanse—76 mm.

Sept.–Oct., 1926, 1 ♀.

A single, very worn ♀ in the Joicey Collection from Cameroons evidently belongs here.

46. **Achaea boris.**

Blosyris boris, Geyer, Zutr. Ex. Schmett., v, p. 42, ff. 973–4 (1837) (S. Africa).

March, 1 ♂.

47. **Achaea renata,** Strand.

Arch. Naturges, 79 A. 8, p. 74 (1914) (Nigeria).

10–24 Jan., 1 ♀.

In Cat. Lep. Phal. xii., Hampson very briefly diagnoses this species as *boris* Ab. i: "fore-wing with the reniform filled in with blackish." To me it appears to be an abundantly distinct though rare species, distinguished from *boris* not only by the conspicuous black reniform (with pale spot at centre) but also by the strong distal bend of the medial and postmedial lines to about R^1, behind which the postmedial is more highly dentate but less curved than in *boris*, the medial strongly bent outward round the reniform (which it touches at both ends), thence more erect. On the hind-wing the postmedial is more strongly curved, rather nearer termen at the radials, more remote at hind margin. The underside is paler in *renata* than in *boris*, with the hind-wing much more weakly marked, the fore-wing with dark discal spot and terminal patch from R^2 to near tornus but with the other markings weak. In the São Thomé specimen the medial line on fore-wing above is double throughout; in the type of *renata* the line is obsolescent round the reniform and appears to be single.

48. **Achaea finita.**

Ophisma finita, Guen., Spec. Gén. Lép., vii, p. 242 (1852) (Bourbon).

24 Jan.–25 Feb., 1 ♂.

49. **Achaea usitata,** sp. n.

Very near *albicilia*, Wlkr., Spec. Lep. Ins., xiv, p. 1374 (1858) (Sierra Leone), but differs in the following particulars; ground-colour of fore-wing darker, more cinnamon-brown (Ridgway, pl. xv); fringe less white; antemedial line more oblique (though waved) throughout; dark shade between medial and postmedial stronger; postmedial less dentate and without white points on veins, oblique to R^1, thence *evenly* and very weakly concave (not angled in at fold); pale postmedial on hind-wing continued to tornus; wings more darkened beneath, with medial line rather more distinct.

Expanse—♀, 56 mm.

10–24 Jan., 2 ♀♀.

A single ♀ from Lagos in the Joicey Collection may well belong to this species, but is without the pale postmedial on hind-wing.

50. **Achaea tornistigma.**

Achaea tornistigma, A. E. Prout, Bull. Hill. Mus., i, p. 125, pl. xvii, f. 8 (1921) (Brit. Cent. Africa).

Sept.–Oct., 1 ♀.

This specimen has the antemedial line more uniformly oblique from about *SC* to hind margin than in the type-form and hardly shows the typical black tornal spot. In all probability a new race, but in the absence of the typical ♀ and the São Thomé ♂ it has seemed unwise to give a subspecific name.

51. **Parallelia palpalis distincta,** subsp. n.

Differs from typical *palpalis*, Wlkr., Spec. Lep. Ins., xxxiii, p. 968 (1865) (Sierra Leone), in the rather larger average size, the slightly deeper ground-colour (unless this always fades in older specimens), and, especially, in the straighter, more sharply-defined antemedial line, with more distinct dark proximal shading but almost without a trace of the distal shade found in the fold in *palpalis palpalis*; in subspecies *distincta* the posterior dark shade is almost as intense as the apical spot; the medial line obsolescent; the oblique distal edge of subapical pale patch (from costa to behind SC^4) is quite straight in *distincta*; in typical *palpalis* it is nearly always slightly convex distad.

Expanse—♂, 47–50 mm.

10–24 Jan., 2 ♂♂; 24 Jan.–25 Feb., 1 ♂.

52. **Parallelia nesites,** sp. n.

Head and patagia ochraceous-buff to ochraceous-orange (Ridgway, pl. xv). *Fore-wing* coloured much as in *palpalis*, but with the dark shades more mixed with tawny, more broken up. Subapical pale patch less distinct, hardly indented on distal side, with patch of dark shading on its distal half, leaving only the edge narrowly pale; differs from all other known species of the *palpalis* group in the distally convex antemedial line, which is well bent outward in fold and slightly bent inward on M and SM^2, rather broadly dark shaded proximally; medial and postmedial lines better defined than in *palpalis*, with a weak line between them (nearer to medial); tawny-brown shades on proximal and distal sides of subapical pale patch, joined together behind the patch and running in a weak curved

clouding to hind margin, dividing at about M^2, the distal half ending at tornus, the proximal near postmedial line. White spots on costa of fore-wing near apex indistinct above, absent beneath, the underside almost without the tawny patches of *palpalis*.

Expanse—♂, 45–50 mm.

10–24 Jan., 3 ♂♂.

53. **Parallelia algira.**

Noctua algira, Linn., Syst. Nat., ed. xii, p. 836 (1767) (Algiriae).

March, 1 ♂, 1 ♀.

54. **Parallelia goniophora diamesa,** subsp. n.

Differs from typical *goniophora*, Hmpsn., P.Z.S., 1910, p. 422, pl. xxxvii, f. 15 (Congo), in having the postmedial line much more strongly bent outward at the medials and to hind margin—somewhat intermediate to *triplocyma*, Hmpsn., Cat. Lep. Phal., xii, p. 604, pl. ccxxi, f. 17 (1913) (Br. C. Africa), which may well be a rather extreme race of *goniophora*. Subspecies *diamesa* is a little greyer in tone than typical *goniophora*, especially on proximal half of fore-wing.

Expanse—48 mm.

10–24 Jan., ♂ type only.

55. **Parallelia angularis.**

Ophiusa angularis, Boisd., Faun. Ent. Mad. Lep., p. 103, pl. 13, f. 2 (1833) (Madagascar).

24 Jan.–25 Feb., 1 ♂; Sept.–Oct., 1 ♂.

This widely distributed African insect does not seem to show much racial variation.

56. **Parallelia glaphyra,** sp. n.

Very near to *prorosigna*, Hmpsn., Cat. Lep. Phal., xii, p. 607, pl. ccxxi, f. 19 (1913) (Uganda), from which it differs in the following points. In *prorosigna* the subapical black spot (about SC^5) is rather larger; the postmedial line after running obliquely to an angle at R^1, is distally convex, then strongly bent inward to M^2; in *glaphyra* this line is proximally oblique and dentate on the veins from R^1 to M^1 (the tooth on R^2 weak), distally concave from M^1 to SM^2, but with a weak distal tooth on M^2; ante- and post-medial lines nearer together at hind margin in ♀♀ than in ♂♂—perhaps slightly closer in *prorosigna* ♀ (type) than in *glaphyra*. On the hind-wing above *prorosigna* has distinct traces of pale postmedial and subterminal lines, which are almost entirely wanting in *glaphyra* except for a pale dash at tornus. On the fore-wing *glaphyra* has a slight dark mark in fold on distal side of post-medial line.

Expanse—♂, 41 mm.; ♀, 35 mm.

10–24 Jan., 1 ♂, 1 ♀; Sept.–Oct., 3 ♀♀.

There seems to me little doubt that *glaphyra* will prove to be merely a race of *prorosigna*; but I refrain from sinking it without more evidence, on account of the different postmedial line, etc., and of the very close resemblance between certain African Parallelias which have been found to differ in genitalia. West African specimens agree with *glaphyra* rather than *prorosigna*.

57. **Grammodes geometrica.**

Noctua geometrica, Fabr., Syst. Ent., p. 599 (1775) (India).

10–24 Jan., 1 ♂.

58. **Mocis frugalis.**

Noctua frugalis, Fabr., Syst. Ent., p. 601 (1775) (India).

10–24 Jan., 2 ♂♂, 1 ♀; 24 Jan.–25 Feb., 3 ♂♂, 2 ♀♀; March, 1 ♀; Sept.–Oct., 1 ♀.

This insect appears much commoner in the Indo-Australian Region than in Africa.

59. **Mocis undata.**

Noctua undata, Fabr., Syst. Ent., p. 600 (1775) (India).

10–24 Jan., 1 ♀; 24 Jan.–25 Feb., 2 ♂♂; March, 1 ♂, 2 ♀♀.

60. **Pericyma polygramma,** Hmpsn.

Cat. Lep. Phal., xiii, p. 311 (1913) (Transvaal).

10–24 Jan., 3 ♀♀.

These specimens appear to belong to *polygramma*. Although they will probably be found to differ racially from the Transvaal form, there is too little material to hand at present for me to attempt any racial determination —especially in the absence of the São Thomé ♂.

Diptherinae.

61. **Elaeodes thomae,** sp. n. (Plate XXI, fig. 16.)

This belongs to Section ii of Hampson; "Antennae of ♂ serrate and fasciculate." Otherwise resembles *barnsi*, A. E. Prout, A.M.N.H., (9) viii, p. 21 (1921) (Tanganyika), from which it differs in the following particulars. Both wings rather narrower, the hind-wing tinged with yellow, especially towards termen, with yellowish veins and terminal line, the fringe chequered with yellow. *Fore-wing* with the lines and stigmata pale green (not white), the subbasal line less distinct than in *barnsi*; cell broadly darkened between stigmata, with more or less distinct anterior dark clouding to costa, the costa with three dark lines, antemedial, medial and postmedial; postmedial line dentate from behind costa to M^2, with narrow distal dark shade which leaves the line at M^2 and runs obliquely to tornus; subterminal line weaker, more dentate than in *barnsi*, with the proximal dark mark behind SC^4 often weak, always small. *Hind-wing* with discal spot usually weak, but often with traces of a postmedial line (following curve of termen), formed by short drab streaks on the veins. *Underside* of both species with the dark shading somewhat variable, but in *thomae* the postmedial line on hind-wing is much further removed from the discal spot at about SC, R^1—midway to termen.

Expanse—♂, 33–36 mm.

10–24 Jan., 2 ♂♂; 24 Jan.–25 Feb., 4 ♂♂.

Plusianae.

62. **Plusia phocea,** Hmpsn.

A.M.N.H., (8) v, p. 433 (1910) (Natal).

10–24 Jan., 3 ♂♂.

The two ♂♂ which are in good condition appear darker, more richly coloured than typical *phocea*. The white dot on fore-wing is minute, placed in two specimens behind the cell, as in *phocea*, in the third at angle of cell, as in *livida*, Holl. Very probably a good race, but there is insufficient material for a definite determination.

63. **Plusia edora,** sp. n. (Plate XXI, fig. 17.)

♂ with strong lateral and anal abdominal tufts, the former brushed upward, the tips meeting on distal half of dorsum. Head and patagia pale buff shaded with brown; thorax pinkish-white, mixed with brown and with a little buff (chiefly on mesothoracic crest); abdomen pale drab, the tufts buff, the large crest on segment 2 (?) more chocolate, with a few black scales. *Fore-wing* pale orient-pink (Ridgway, pl. ii), the area between ante- and post-medial lines, from *M* to hind margin metallic bronze, the medial area from costa to *M* shaded with purplish-fuscous, with slight traces of pink and bronze shades; proximal area obliquely irrorated with brown or blackish to near antemedial line, but intersected by a white basal spot before *M*, whitish subbasal lunules behind costa and *SC*, pale veins and a horizontal white bar before *SC*; antemedial line a distally oblique white bar from *fully* $\frac{1}{3}$ costa to *SC*, resumed as a fine, nearly horizontal streak behind *M*, followed (at less than $\frac{1}{3}$ wing) by a broader distally and obliquely convex whitish line in fold with slight curve behind SM^2 to near base of hind margin; orbicular a rhomboidal dark spot outlined at sides and behind with whitish and with a large, complete Y-mark behind it, with the tail short and broad, the proximal side of the V somewhat produced and bent so as almost to join the narrow bar of the antemedial line; reniform kidney-shaped but very narrow, somewhat pale on the dark patch, but black-edged at sides; postmedial line slight, pinkish with brown edgings, bent outwards from $\frac{2}{3}$ costa, undulating but more or less parallel with termen to behind M^2, bent outward to near tornus, shortly dentate distally on M^1 and M^2 proximally between them; subterminal line indicated chiefly by a bronze-brown shade on proximal side, bent outward behind SC^5 and M^1; the usual terminal dark spots (or lunules) between veins; fringe worn. *Hind-wing* whitish at base, gradually darkened to termen, with a rather distinct, nearly straight postmedial line at about $\frac{3}{5}$. Wings *beneath* pale drab (rather worn), both wings with rather distinct, nearly straight postmedial line, from about $\frac{5}{7}$ costa of fore-wing to nearly $\frac{2}{3}$ hind margin of hind-wing.

Expanse—♂, 36 mm.

10–24 Jan., 1 ♂.

A handsome species slightly recalling *dormfeisteri*, Fldr., Reise. Nov., pl. 110, f. 33 (1874) (Cape Colony), though not quite so strongly contracted as that beautiful little insect. Although slightly worn, *edora* should be easily distinguishable by the above description and the locality.

64. **Plusia signata,** Fabr.

Ent. Syst., iii, 2, p. 81 (1792) (E. India).

March, 1 ♂, 3 ♀♀. Also (species ?) 1 ♀, 10–24 Jan.

The ♀ taken in January is noticeably larger and darker than the March specimens, but it appears to belong to the same species.

This may well be a local race, having a more distinct dark spot at middle of fringe of fore-wing than most *signata* specimens. But even Indian and African specimens have not as yet been differentiated, so it has seemed best to list the São Thomé specimens merely as *signata*.

Ophiderinae.

65. **Tavia nycterina lyga,** subsp. n.

Differs from typical *nycterina*, Boisd., Fauna Ent. Mad., p. 109, pl. 13 (1833) (Madagascar), largely in the shape of the ♂ fore-wing (the Madagascar ♀ is not before me), which in subspecies *lyga* has the costa slightly more highly arched, the termen rather more oblique,

almost concave before tornus; in *nycterina lyga* R^2 and R^3 are approximated to fully $\frac{1}{3}$, in *nycterina nycterina* to little over $\frac{1}{4}$. Notwithstanding these minor differences in the ♂ structure, *lyga* appears to me to be no more than a local race of *nycterina*, from which it differs only very slightly in pattern. In subspecies *lyga* the ground-colour above and beneath is more purplish-black; the subterminal line is proximally rather more narrowly dark-edged, the line itselt being slightly more incurred behind R^3. From *plicata*, Hmpsn., P.Z.S., 1910, p. 429, pl. xxxvii, f. 25 (N.E. Rhodesia), which is apparently another *nycterina* race, having approximately the same distortion of veins on ♂ fore-wing, subspecies *lyga* differs in the absence of the white spot proximally to subterminal line on fore-wing (omitted in figure) and of white terminal dots on both wings, as well as in the less dentate subterminal line. In subspecies *plicata* the approximation of R^2 and R^3 is if anything shorter than in typical *nycterina*.

Expanse—♂, ♀, 52 mm.

10–24 Jan., 1 ♀; 24 Jan.–Feb., 25 1 ♂.

66. **Bareia incidens,** Walkr.

Spec. Lep. Ins., xv, p. 1840 (1858) (Natal).

10–24 Jan., 2 ♂♂, 4 ♀♀; 24–25 Jan. Feb., 4 ♀♀.

67. **Anophia leucomelas thomae,** subsp. n.

Differs from typical *leucomelas*, Linn., Syst. Nat., ed. x, p. 518 (1758) (Europe), in the slightly narrower fore- and hind-wing (especially in ♀) and in the more blackish tone of the dark band on hind-wing and ground-colour of ♀ fore-wing; the ♂ fore-wing has also some more blackish (less brownish) shades, but is much more variegated with buff and bluish-grey, more as in some Indian ♂♂ of *leucomelas* rather than any European specimens in the Joicey Collection. The pale bars before and behind the proximal third of M^2 are strong in the ♂, moderate in the ♀; in the latter this is almost the only distinct pale marking, all markings being weaker than in the ♂. The apical pale patch on hind-wing does not reach to much behind R^1 (to R^2 in typical *leucomelas*). The yellow androconia on ♂ hind-wing beneath appears rather weaker in subspecies *thomae*, and neither ♂ nor ♀ has the abdominal crests quite so noticeable as in most European *leucomelas*; but these latter points may be chiefly due to not quite fresh condition.

24 Jan.–25 Feb., 1 ♂, 1 ♀.

Although these are the first *leucomelas* specimens known to me from non-palaearctic Africa there can hardly be any doubt as to the species.

68. **Facidia vacillans,** Wlkr.

Trans. Ent. Soc., iii, Series 1, p. 95 (1862) (Cape).

10–24 Jan., 2 ♂♂.

These ♂♂ are very dark, with a small dark reniform; but they hardly seem to differ sufficiently from typical *vacillans* to require a separate subspecific name.

69. **Delgamma sanctae,** sp. n. (Plate XXI, fig. 13.)

Closely resembles *pangonia*, Guen., Spec. Gén. Lép., vii, p. 214 (1852) (hab. ign., given as Brazil ?), from which it differs in the more flesh-colour (less violet) tone of the pale shade on distal edge of postmedial line and, especially, in the reduction of this shade on the hind-wing, the postmedial line arising only at or behind R^3 instead of at or before R^2, and in the complete absence of the black-and-white dentate marks beyond the line. There is scarcely

a trace of white behind the subapical dark mark on fore-wing, the mark itself being formed as in Ceylon specimens of *pangonia*, without the two small spots behind the larger one, which are mentioned in Guenée's description and which are present in specimens from Sikkim, Tonkin, Sumatra, Borneo and New Guinea in the Joicey Collection but are absent in all four specimens from Ceylon; postmedial line without undulations. *Underside* nearly as in Ceylon specimens of *pangonia*, but almost without the pinkish-violet tints. Head and patagia without the golden shades of typical *pangonia* (as in Ceylon specimens).

10–24 Jan., 2 ♀♀.

This is probably no more than a race of the Ceylon form of *pangonia* (which certainly requires a distinct name); but the fact that Ceylon and São Thomé specimens have so much in common and are so distinct in many ways from specimens occurring from India to New Guinea rather suggests a specific than a racial difference from *pangonia*; especially as specimens from West Africa are in some ways nearer to typical *pangonia* than to specimens from Ceylon and São Thomé. All may, however, be distinct species; the ♂, unfortunately, seems rarer than the ♀, so that there is little opportunity of studying genitalia or secondary sexual differences.

70. **Serrodes trispila cordifera,** subsp. n.

Differs from typical *trispila*, Mab., Soc. Ent. Fr., (6) x, p. 45 (1890) (W. Africa), chiefly in the conspicuously pale veins of proximal half of fore-wing (especially in the ♂) and in the shape of the antemedial black mark in fold, which is strongly oblique outward on distal side from just behind *M* to just before SM^2 (to which it is slightly bent inward); in the ♀ this mark is especially strongly produced distally. The fore-wing is, perhaps, even more distinctly angled at R^3 than in typical *trispila* and in the ♂ the area between ante- and post-medial lines is more variegated, more irrorated with black than in the majority of *trispila* ♂♂, with a glossy black patch between the reniform and postmedial line, from $SC^{4,5}$ to M^1, interrupted by the pale veins; in the ♀ this area is more as in typical *trispila* ♀♀, but with the two grey medial lines much less strongly waved, the four greenish, black-ringed dots on distal side of reniform of nearly equal size; in one ♂ the ground-colour of this area is buff, in the typical ♂ and the ♀ buff largely tinged with rufous; the proximal and distal thirds of wing are leaden-purple, paler in ♀ than in ♂; the dentate subterminal dotted line is unusually distinct in the ♂. On the hind-wing subspecies *cordifera* differs in having the white spots on fringe more buff, less conspicuous than in typical *trispila* both above and beneath.

Expanse—♂, 62 mm.; ♀, 58 mm.

10–24 Jan., 1 ♀; 24 Jan.–25 Feb., 2 ♂♂.

This may be a distinct species, but, in spite of the noticeably different black spot in fold, the differences appear to me no more than may well be racial.

71. **Marcipa acuta,** sp. n. (Plate XXI, fig. 18.)

Near in shape to *inscripta*, Wlkr., Spec. Lep. Ins., iv, p. 808 (1855) (Sierra Leone), but fore-wing with the apex more strongly produced, the termen quite distinctly angled at R^3. *Fore-wing* deep brownish-drab (Ridgway, pl. xlv), a little paler on proximal and distal areas, deeper between ante- and post-medial lines, the dark medial area edged on both sides with bister, narrowly to *M*, more broadly to the scale-teeth on hind margin; ante-medial line bent outward from hardly $\frac{1}{3}$ costa to middle of cell, thence oblique to about $\frac{1}{4}$ hind margin; orbicular, reniform and dark subapical spot very deep bister, shaped nearly as in *inscripta*; postmedial line nearly as in *dimera*, Hmpsn., Lep. Phal., p. 169 (1926) (Old Calabar), but distinctly bent at R^1 and distally concave behind M^1; an almost continuous dark line before termen, in place of spots at termen; fringe blackish with pale

line at base. *Hind-wing* and underside nearly as in *inscripta*, but the latter, especially, much more darkened, greyer. Head, thorax and abdomen (as usual) approximately matching wings. ♂ antenna and mid tibia as in *inscripta*.

Expanse—♂, ♀, 38–41 mm.

10–24 Jan., 1 ♀; 24 Jan.–25 Feb., 2 ♂♂.

72. **Hypocala dysdamarta,** sp. n.

Hardly differs in the ♂ from some African forms of *rostrata*, Fabr., Naturf., p. 197, pl. iv, f. 4 (Central India), but with the black shades on hind-wing a trifle broader and blacker—distinctly broader and blacker than in the majority of *rostrata* specimens; the black markings broadened on both wings beneath and the ground-colour slightly deeper, more ochreyellow; this ♂ belongs to the violet-grey form, shaded with reddish-brown on anterior half to postmedial line and with markings, except subterminal line, very indistinct. The ♀ is even more indistinctly marked on the fore-wing, which is coloured nearly as in an extra-grey specimen of *violocea*, Butl., Tr. Ent. Soc., 1879, p. 6 (Cachar), but retains the distinct subterminal on posterior half of wing; hind-wing almost as heavily darkened as in *violacea*; wings beneath also more heavily clouded with black than in the ♂—especially on the fore-wing.

Expanse—♂, ♀, 40 mm.

10–24 Jan., 1 ♀; 24 Jan.–25 Feb., 1 ♂.

This is a confusing genus, difficult to sort with certainty, but *dysdamarta* appears new to science.

73. **Gesonia obeditalis,** Wlkr.

Spec. Lep. Ins., xvi, p. 75 (1858) (Ceylon).

10–24 Jan., 1 ♀.

The extreme variability of this widely-distributed insect renders it most difficult to judge of its racial variation.

74. **Gesonia stictigramma,** Hmpsn. (?).

24 Jan.–25 Feb., 1 ♂.

A worn specimen, but may well belong to this species.

75. **Othreis materna.**

Phalaena-Noctua materna, Linn., Syst. Nat., 1, 2, p. 840 (1767) (Java).

March, 1 ♀.

76. **Anomis leona.**

Gonitis leona, Schs., Lep. Sierra Leone, p. 36, pl. iii, f. 10 (1893) (Sierra Leone).

24 Jan.–25 Feb., 3 ♂♂, 4 ♀♀; March, 1 ♀.

These specimens do not seem to differ from West African *leona*.

77. **Anomis iobapta,** sp. n. (Plate XXI, fig. 19.)

Fore-wing acute at apex, concave to R^3, where it is angled, oblique to hind margin; segment 3 of palpus exceptionally long (nearly as long as segment 2). Head, thorax and fore-wing predominantly buff suffused with ferruginous, the wing washed with light vinaceous between postmedial and subterminal line; fold somewhat pale beyond antemedial, which is oblique from near $\frac{1}{4}$ costa to $\frac{2}{5}$ hind margin but distally concave between the veins,

somewhat obscure; stigmata rather obscure, white, the orbicular a dark-ringed dot, reniform lunular, proximally dark-edged; postmedial line fine, blackish, distally pale-edged, outwardly oblique from $\frac{5}{7}$ costa to SC^5, somewhat oblique and slightly incurved to nearly $\frac{5}{7}$ hind margin; a slight subterminal dark shade dividing the pale area from the ferruginous terminal one, rather acutely angled outward behind R^3 and less strongly bent inward behind R^1 and at M^2; fringe dark. *Hind-wing* and abdomen above nearly uniform dark drab. *Underside* of fore-wing drab, the costa and the termen to M^1 flushed with pink; hind-wing light congo pink (Ridgway, pl. xxviii), white at base and hind margin, with black dots on the veins and a pink line to hind margin representing postmedial line, which follows the curve of the termen.

Expanse—♀, 29 mm.

10–24 Jan., 1 ♀.

A very closely related species, or local race, occurring in the Cameroons has the ♂ antenna nearly simple (very short bristles and cilia), apparently without any sexual specialisation.

78. **Saroba crassisquama.**

Bonaberiana crassisquama, Strand, Ent. Mitteil., iv, No. 4/6, p. 161 (1915) (Cameroons).
= *Saroba cynescens*, Hmpsn., Lep. Phal., p. 414 (1926) (Natal).
= *Mesosciera picta*, Hmpsn., Lep. Phal., p. 532 (1926) (S. Nigeria).

Sept.–Oct., 1 ♀.

The position of this widely distributed but not common insect seems uncertain. Should it be found to require a separate genus, Strand's name of *Bonaberiana* will stand for it.

79. **Anticarsia irrorata.**

Noctua irrorata., Fabr., Spec. Ins., ii, p. 506 (1781).

10–24 Jan., 1 ♂.

Hypeninae.

80. **Adrapsa occidens,** sp. n. (Plate XXI, fig. 14.)

In the ♀ structure agrees almost perfectly with *ablualis*, Wlkr., Spec. Lep. Ins., xvi, p. 170 (1858) (Ceylon), but segment 2 of palpus is perhaps a little more strongly thickened at middle behind. Palpus, head, thorax and fore-wing coloured nearly as in *ablualis*, but the dark shades blacker. Markings of *fore-wing* much as in *ablualis*, the buff costal shade rather broad and pale; white postmedial not excurved round cell; subterminal very narrowly white before hind margin in addition to the strong white mark opposite cell. *Hind-wing* much more variegated than in *ablualis*, base of wing, discal spot, termen from apex to near R^3 and tornus all white; white postmedial rather broad; a slight shade defining the crenulate white subterminal from costa to R^3. *Wings* beneath more black and white than in *oblualis*, fore-wing with the postmedial line nearer disc; the pale patch on anterior $\frac{1}{2}$ of termen of hind-wing much more ill-defined than above (with dark irroration on it).

Expanse—30 mm.

24 Jan.–25 Feb., a single ♀.

Judging from this specimen alone, *occidens* might well be merely a race of *ablualis*; but a single worn ♂ from Cameroons, probably belonging to the same species (possibly local race), has the antennal shaft merely a trifle thickened, without any trace of the dense blackish tuft of *ablualis*. This is the only *Adrapsa* known to me from Africa, but the genus is quite unmistakable.

81. **Hydrillodes thomensis,** sp. n.

Palpus nearly as in *lentalis,* Guen., Spec. Gén. Lép., viii, p. 66, pl. 5, f. 3 (1854) (Cent. India), but ♂ with segment 2 slightly longer, more strongly curved at distal end, segment 3 slightly shorter, more strongly recurved, slightly convex below, acute, the distal $\frac{1}{3}$ slender, slightly thickened with scales above on proximal $\frac{2}{3}$; ♀ with segment 2 rather longer, 3 rather shorter than in *lentalis*; comparison is with Ceylon specimens, there being no Indian available. ♂ hind-wing beneath with yellow androconia, nearly as in *subflavalis,* Hmpsn., J. Bomb. Soc., xvii, p. 669 (1907) (Ceylon), which should probably sink to *Catada captiosalis,* Wlkr., Spec. Lep. Ins., xvi, p. 210 (1858) (Ceylon), but there is no trace of the long loose yellow hair of *subflavalis*; in the palpus *subflavalis* is even more remote than *lentalis* from *thomensis,* having segment 3 nearly as long as 2 (about $\frac{3}{4}$?), stout to quite near tip and hardly recurved, segment 2 not curved at distal end. *Fore-wing* much as in *lentalis,* ♂ apparently much more unicolorous than ♀ (worn); *hind-wing* much more darkened than in either *lentalis* or *subflavalis,* with discal spot and postmedial line weak, subterminal practically obsolete. *Wings* beneath in the ♂ nearly as in *subflavalis* ♂, in the ♀ nearly as in *lentalis* ♀, but with more dark irroration, more buff on anterior half.

Expanse—♂, ♀, 25–28 mm.

10–24 Jan., 3 ♀♀; 24 Jan.–25 Feb., 1 ♂, 1 ♀.

This is probably a race of an apparently unnamed species from Madagascar, with which it seems to agree in structure, but Madagascar specimens (♂ and ♀) have the hind-wing almost white above, pure white beneath, except for the discal spot, lines and ♂ androconia.

Ableptina, gen. nov.

Tongue, eye and face normal. Palpus: segment 1 normal; segment 2 upcurved, about $1\frac{3}{4}$ (♂)—twice (♀) diameter of eye, apparently glabrous behind, shortly and smoothly (?) scaled in front; segment 3 slender, acute, glabrous, about $\frac{3}{4}$ length of 2 in ♂, $\frac{3}{5}$ to $\frac{2}{3}$ in ♀. ♂ antenna with fine, short bristles and shorter ciliation; the shaft bent and tufted at about $\frac{2}{5}$, recalling the genus *Nodaria.* Thorax clothed chiefly with scales, apparently without crests. Abdomen apparently without crests. Legs about normal. *Fore-wing* not broad, costa flattened; apex more acute in ♀ than in ♂; termen rounded, crenulate; no secondary sexual fold or tufts; cell about $\frac{1}{2}$; areole moderate, chiefly beyond cell, with SC^2 and SC^5 given off before end, SC^3, SC^4 from end, stalked to about $\frac{1}{2}$ from angle of cell; other veins practically normal. *Hind-wing* costa normal, termen rounded; cell about (fully ?) $\frac{2}{5}$; anastomosis to nearly $\frac{2}{5}$; SC^5, R^1 and R^3, M^1 very shortly stalked; R^2 curved, practically from angle; M^2 and SM^2 normal. Retinaculum a short, oblique bar.

Type: *delospila,* sp. n.

82. **Ableptina delospila,** sp. n.

♂ thorax and *fore-wing* pale sepia (Ridgway, pl. xxix); ♀ more snuff-brown (*l.c.*); ♀ with a dull chocolate shade between medial and postmedial lines which is lacking in the ♂. Lines very indistinct, especially the inner ones, antemedial just traceable, from hardly beyond $\frac{1}{4}$ costa, erect but showing only as distal convexities behind costa, in fold and behind SM^2; medial shade bent outward from costa, crossing the disc, inwardly oblique to middle of fold, erect to hind margin (in ♀ showing only as edge of chocolate band); postmedial line bent outward from costa, distally convex (almost angled) about R^3 and R^1, thence as medial line but more waved; subterminal pale, proximally dark-edged, strongly bent outward behind SC^5 and R^3, forming (proximally) a blackish spot between SC^5 and R^1, which is the most outstanding feature of this insect; the ♀ sometimes with a smaller blackish spot behind R^3; a small dark (orbicular) spot in cell and dark discal lunule; the

terminal dark spots distinct; fringe pale between the veins. *Hind-wing* pale drab, with slight dark discal lunule and traces of pale subterminal, somewhat as in *Nodaria* and *Simplica*. *Underside* of fore-wing drab, the costa olive-brown; hind-wing white with buff irroration on anterior $\frac{1}{2}$, dark discal spot and crenulate postmedial and subterminal lines —recalling *Hydrillodes*.

Expanse—♂ 26 mm.; ♀ 28–29 mm.

10–24 Jan., 1 ♂; 24 Jan.–25 Feb., 4 ♀♀.

Bleptina nephelopera, Hmpsn., Trans. Zool. Soc., xix, p. 115, pl. iv, fig. 26 (1909) (Ruwenzori) appears to belong here, but as it is known only in the ♀ it has seemed advisable to make *delospila* the genotype.

Aulocheta, gen. n.

Tongue, eye and face normal. Palpus about as in *Ableptina*, but segment 3 rather longer in ♀ than in ♂, instead of shorter. ♂ antenna weakly serrate, with long curved bristles; ♀ with long slender bristles and short ciliation. Thorax clothed with rather narrow scales and hair without distinct crests. Abdomen with some loose hair on dorsum but apparently without crests. Legs normal. *Fore-wing* of medium breadth; costa flattened except at base and apex; apex hardly acute; termen rounded (slightly bent about R^3), crenulate; hind margin a little rounded on proximal $\frac{1}{2}$; no secondary sexual fold or tufts; cell about $\frac{1}{2}$; areole absent (or minute ?); SC^2, SC^3, SC^4 stalked, from angle, SC^2 to about $\frac{2}{5}$, SC^3, SC^4 to about $\frac{3}{5}$, the stalk bent so that SC^2 rather than SC^3, SC^4 appears its continuation; SC^5 from angle (or areole ?); other veins normal. *Hind-wing* highly crenulate; cell about $\frac{2}{5}$; anastomosis to fully $\frac{1}{3}$; R^2 from about $\frac{4}{5}$; other veins normal. Retinaculum concealed by rather coarse, strong hair; apparently a short oblique bar.

Type: *violacea*, sp. n.

83. **Aulocheta violacea,** sp. n. (Plate XXI, fig. 21.)

Palpus, head, and thorax, fuscous with white intermingled. *Fore-wing* deep-violet-plumbeous (Ridgway, pl. xlix), shaded with violet-slate (*l.c.*), with more or less fuscous irroration; lines fuscous, waved; subbasal represented by thick, almost united fuscous patches behind costa and in cell; antemedial nearly erect, from about $\frac{2}{7}$ costa to $\frac{1}{3}$ hind margin, distally convex behind costa, M^2 and SM^2 (almost angled behind M); a distinct medial shade, bent outward from $\frac{3}{7}$ costa to disc, slightly oblique or distally concave to near middle of hind margin; postmedial double, crenulate, slightly bent outward from nearly $\frac{2}{3}$ costa, nearly erect to R^3 (but bent inward opposite cell), slightly bent inward to M^1 and strongly so to the middle of fold, bent outward to SM^2 and erect to margin; subterminal sharply defined by a fuscous discal shade, proximally toothed behind SC^4, distally quadrate and near termen between SC^5 and R^1, proximally convex behind R^1, distally so and minutely dentate on R^3, M^1, rather strongly bent inward behind M^1 (but with slight tooth on M^2), with sharp (distal) tooth on SM^2; a small black (orbicular) spot in cell; discal spot large, black, strongly produced and rounded on its proximal side, weakly concave distally; terminal black lunules strong; fringe drab, darkened at veins. *Hind-wing* drab, with weak, pale postmedial and subterminal lines on posterior half, the former near the middle of wing, distally dark-edged, preceded by slight medial shade, subterminal chiefly visible at tornus. *Underside* of fore-wing drab, with slight, pale postmedial and subterminal lines; hind-wing white with buff and fuscous irroration; discal spot, proximal edge of postmedial and distal border to subterminal fuscous.

Expanse—♂, ♀, 35 mm.

10–24 Jan., 1 ♂, 1 ♀.

A very distinct little insect, almost more Ophiderid than Hypenid in appearance; but from the palpus and tympanum it appears almost certainly to belong in the Hypeninae.

Ctenypena, gen. n.

Tongue, eye and face normal. Palpus: segment 1 appears just over diameter of eye, curved; segment 2 straight or almost downcurved in form but upwardly oblique in position, more than twice eye, with rather loose but very short hair in front and behind, lengthened to a fairly long tuft on distal half behind; segment 3 relatively short (about $\frac{2}{5}$ of 2), straight, acute, with very short hair in front and behind. ♂ antenna with unusually long, drooping pectinations. Thorax clothed with hair and some narrow scales, metathorax apparently with thick, compact crest. Abdomen apparently without crests. ♂ fore leg apparently with narrow, closely-fitting sheath extending to end of segment 1 of tarsus, tibia short (about $\frac{1}{3}$ length of tarsus?); middle leg normal; hind leg wanting. Wings very slender. *Fore-wing* rather broad; costa flattened, almost concave at middle; apex hardly acute; termen oblique, weakly, curved crenulate; hind margin normal; cell a little over $\frac{1}{2}$; areole narrow, chiefly beyond cell, with SC^2 from well before end, SC^5 connate (almost stalked) with SC^3, SC^4, which are stalked to nearly $\frac{1}{2}$ from angle; M^1 from unusually far behind angle; other veins normal. Hind-wing costa flattened, termen rounded; cell about $\frac{3}{7}$; SC^5, R^1 stalked to nearly $\frac{1}{4}$; R^2 practically from angle; other veins normal. Retinaculum a very short tunnel (almost quadrate).

Type: *tenuis*, sp. n.

84. **Ctenypena tenuis,** sp. n. (Plate XXI, fig. 23.)

Antenna, palpus, head and thorax sepia (Ridgway, pl. xxix). *Fore-wing* shaded and irrorated with sepia with a tinge of bister (*l.c.*), especially between ante- and post-medial lines; some fuscous irroration; a fuscous patch at base, from costa to M; subbasal blurred, nearly erect, thickened between veins; antemedial apparently nearly erect from about $\frac{2}{7}$ costa to $\frac{1}{3}$ hind margin, slightly bent inward before M (and outward at costa? rubbed); postmedial bent outward at costa, distally convex from SC^1 (or^2) to behind R^1 (where it is angled inward) and from behind R^1 to M^2, more erect to margin; a diffused dark subterminal shade, thickened between the veins; strong dark terminal lunules; fringe apparently pale (worn); a slight, diffused dark shade between subbasal and antemedial; orbicular and reniform fuscous nearly of a size, the former rounded, the latter kidney-shaped; veins tinged with buff. *Hind-wing* very pale buff, tinged with drab on distal $\frac{1}{3}$ and with slight drab discal lunule and weakly curved postmedial lines. *Underside* of fore-wing drab, with costa (narrowly), apex and termen bright buff interrupted by a slight drab spot at apex and stronger (subterminal) one between SC^5 and R^1; hind-wing white, with buff and fuscous irroration on anterior $\frac{1}{2}$, the veins buff; a large, diffused discal spot, curved and weakly dentate postmedial line and slight, interrupted subterminal shade all formed of closely-set fuscous irroration.

Expanse—40 mm.

10–24 Jan., a single ♂.

The three preceding genera have been inserted here because the first two undoubtedly belong to the large main group of species with sickle-shaped palpus (at least in the ♀) and bar-shaped retinaculum: *Simplicia*, *Adrapsa*, *Hydrillodes*, etc.; in this group secondary sexual modifications abound, abdominal crests are rare and the hind-wing above has as a rule some traces of lines. *Ctenypena* lies on the borderland between this group and the true *Hypena* section, with porrect palpus, tunnel-shaped retinaculum, much less frequent sexual modifications, abdominal crests frequently present and hind-wing above usually without lines. In the retinaculum *Ctenypena* seems to agree with *Hypena*; in palpus it is intermediate and in the other three points it belongs more to the *Simplicia* group. But its appearance is so distinct, its antenna so unique in the HYPENINAE that it is probably somewhat remote from any other known genus.

The two following genera are also intermediate; in most respects much nearer to *Hypena* than to the *Simplicia* group, but with an upcurved palpus. This, however, is distinctly modified in the *mutilata* group of *Orixa*, which may not really be congeneric with *filifera*, Wlk.

Camphypena, gen. n.

Agrees with *Hypena*, Schrank, in neuration (fore-wing cell about $\frac{3}{5}$. Hind-wing cell about $\frac{3}{7}$; R^2 from about $\frac{2}{3}$, shape, type of pattern, abdominal crests (on at least 3 segments) and retinaculum. But the legs (tibia and tarsus) are longer (about $\frac{1}{2}$ length of costa, over $\frac{2}{3}$ and about $\frac{2}{3}$), the fore tibia almost as long as tarsus; these, however, may probably differ in different *Hypena* species, though it is unusual for the mid tibia and tarsus to be longer than the hind ones; the scaling of thorax is finer (more hair-like) than in typical *Hypena*, and the palpus differs considerably, having segment 2 upcurved, almost pressed against face, little more than diameter of eye, with hair short and compact in front, hardly lengthened at all behind; segment 3 practically glabrous though fairly stout, hardly acute, about $\frac{2}{3}$ length of segment 2.

Type: *thomensis*, sp. n.

85. **Camphypena thomensis,** sp. n. (Plate XXI, fig. 8.)

Head and thorax bister (Ridgway, pl. xxix), the thorax glossed with deep purple, patagia paler bister. *Fore-wing* bister, with area between ante- and post-medial lines rather deeper brown, the lines themselves chestnut defined by buff (the former proximally, the latter distally); antemedial bent outward from nearly $\frac{1}{3}$ costa to *SC*, weakly angled inward in cell and outward to *M*, oblique to just before $\frac{1}{3}$ hind margin; postmedial erect from less than $\frac{2}{3}$ costa to areole, weakly angled distad on R^1 and convex in fold, distally concave between the angles and about SM^2; a black spot in cell near antemedial line and a diffused dark discal shade in angle of postmedial; blackish subterminal spots behind SC^4 and SC^5, with slighter ones behind them (especially behind R^3 and in fold). *Hind-wing* whitish-buff, irrorated with drab, especially towards termen; distal $\frac{1}{2}$ of fringe drab; a faint drab discal lunule. *Underside* of both wings whitish in fold and at hind margin; the rest of the wing irrorated with brownish-drab; fore-wing with whitish spots behind SC^4 and SC^5, the former rather smaller than the latter; hind-wing with diffused, rounded, dark discal spot.

Ab. 1. Postmedial line rather less distally convex in fold; beneath with the white spot behind SC^5 almost obsolete.

Expanse—♂, about 42 mm.

24 Jan.–25 Feb., 4 ♂♂.

86. **Orixa mutilata effusa,** subsp. n. (Plate XXI, fig. 24.)

Differs from typical *mutilata*, Strand, Iris, xxii, p. 118 (1909) (Ruanda), in the slightly smaller size, rather narrower wings (hind-wing especially being less full about the medials), and in the white markings of fore-wing above and beneath. In subspecies *effusa* the white band is less oblique, starting from just beyond $\frac{3}{5}$ costa and reaching hind margin just before termen, with the distal edge more irregular, forming minute teeth on the medials as well as a distinct tooth at the origin of the white streak on R^1; joining this streak anteriorly, nearly half-way to the termen, there is a more or less complete W-shaped white mark, not reaching the costa. On the underside the white band is distally more diffused than in the typical form—especially in the ♂.

Expanse—♂, ♀, 35–39 mm.

10–24 Jan., 2 ♂♂; 24 Jan.–25 Feb., 2 ♂♂, 1 ♀.

The above comparisons are made chiefly with a single ♂ from Ruanda in the

Joicey Collection, but this seems to agree perfectly with Strand's description of *mutilata*. *Effusa* may possibly prove to be a distinct species, but as the resemblance is so close and there appear to be no important structural differences I prefer to regard it as a race of *mutilata*. In the Ruanda ♂ segment 3 of palpus seems slightly more densely scaled, but the São Thomé ♂♂ may all be slightly damaged.

87. **Hypena varialis,** Wlkr.

Spec. Lep. Ins., xxxiv, p. 1136 (1865) (Natal).

10–24 Jan., 3 ♂♂; 24 Jan.–25 Feb., 1 ♂; Sept.–Oct., 1 ♂.
Rather a dark form; may prove racially distinct.

88. **Hypena conscitalis,** Wlkr.

Spec. Lep. Ins., xxxiv, p. 1509 (1865) (Java).

10–24 Jan., 2 ♂♂.
The Indian and African forms are not yet differentiated.

89. **Hypena massurialis,** Guen.

Spec. Gén. Lép., viii, p. 38 (1854) (Cent. India).

Comment on preceding species applies here.

90. **Hypena neoplyta aequabilis,** subsp. n.

Differs from typical *neoplyta*, A. E. Prout, Entom., lviii, p. 218 (1925) (Durban), in the less strongly contrasted fore-wing, with medial area hardly so dark, terminal area distinctly more darkened, with subterminal line much less distinct, nearly obscured by terminal clouding. In the ♂ of *neoplyta aequabilis* the two areas are still more nearly concolorous and the postmedial line is deep buff, hardly pale-edged. The ♂ underside is distinctly paler than the ♀, the ground-colour of hind-wing being almost white.

Expanse—♂, ♀, 26–27 mm.

10–24 Jan., 2 ♂♂, 1 ♀.
The above differences hold good in a series of *neoplyta* from Nyasaland.

91. **Hypena schultzei,** Auriv.

Zent. Afrik. Exped., Lepid., iv, p. 1325, f. 79 (1925) (S. Cameroons).

10–24 Jan., 2 ♂♂, 1 ♀; 24 Jan.–25 Feb., 1 ♂.

The ♂ has postmedial line a little more acutely pointed at its distal angle than in Aurivillius' figure (racial difference?), but otherwise the above specimens seem to agree well with figure and description of type. In the ♀ the postmedial line is even less strongly angled than in the typical ♂ and the proximal $\frac{1}{2}$ of wing is a little deeper in tone (more contrasted) than in the ♂. This species is structurally very near to *H. ituriensis*, A. E. Prout, Bull. Hill Mus., 1, p. 134, pl. xvii, f. 16 (1921) (Congo Belge), with metathoracic crest, large abdominal crests, segment 2 of palpus triangularly tufted, etc. When *Hypena* comes to be worked out this group may possibly form a separate genus.

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NEW NOCTUIDAE FROM SÃO THOMÉ.

THE SPECIFIC CHARACTERS OF THE BRITISH HUMBLEBEES (HYMENOPTERA)

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[Read October 5th, 1927.]

Plates XXII–XXV and Five Text-figures.

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I. Introduction and Acknowledgments.

The species of the genera *Bombus* and *Psithyrus*, to which our humblebees belong, have long been known to show a polymorphic colour-variation of a type similar to that found in many Lepidoptera. These variations have been studied in great detail and a large number of forms have been given names. Little, however, can be deduced from the facts recorded until the relationships amongst the species have as far as possible been elucidated. In the present paper an attempt is made to describe all the specific characters to be found in the chitinous hard parts, and to deduce from these some idea of the inter-relations of the species. The British species have alone been dealt with in full, but in the consideration of certain characters it has been found profitable to include also some of the other species that occur in Europe. The European species have recently been examined by Krüger (1920) with the same object in view; full use has been made of his work, but it was found that there were many important characters which had not hitherto been noticed, and which justify a further paper on this subject in English.

In the concluding paragraphs there is a discussion of those more general problems, connected with the origin of species, on which some light seems to be thrown by a study of the humblebees.

I am much indebted to Messrs. A. H. Hamm, A. E. Bradley, and E. B. Nevinson for the gift of valuable specimens. My thanks are also due to Prof. Goodrich for the laboratory facilities of the Department of Zoology and Comparative Anatomy, and to Prof. E. B. Poulton for allowing me to examine all the material in the Hope Department.

A Zeiss screw-eyepiece micrometer, which was used for making measurements, was purchased with the aid of a grant from the Christopher Welch trustees. Mr. E. B. Ford was kind enough to help me in determining the statistical significance of the measurements.

II. Description of Specific Characters.

Although nearly all the characters here described can be seen with a hand-lens (especially with some practice) yet their study is made very much easier if a binocular microscope is used. In the following account the specific characters are dealt with in order, beginning with the head.

1. *The head.*

The methods of describing the proportions of the parts of the head have been very fully dealt with by Krüger (1920 and 1924). He has shown by

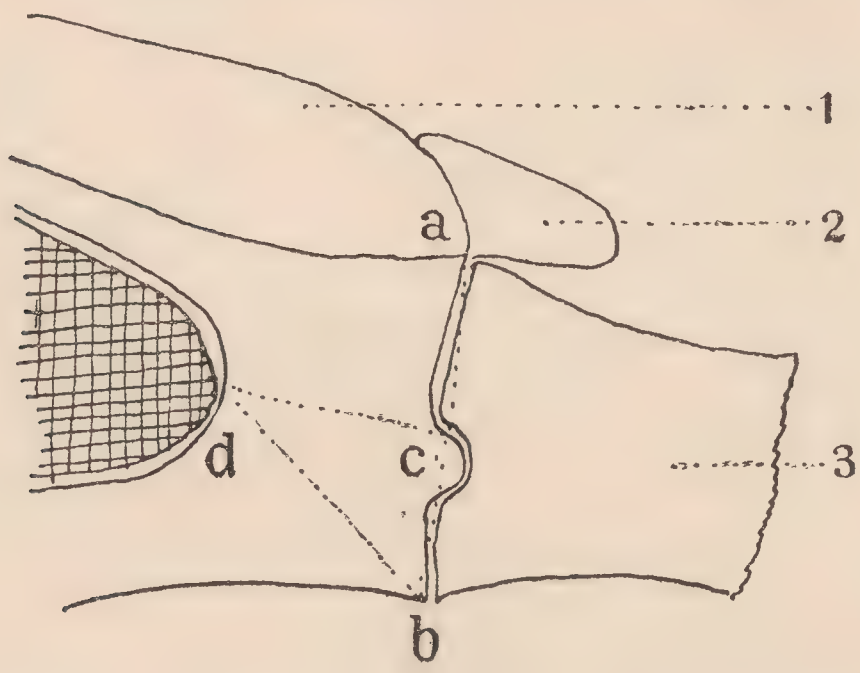

Fig. 1.—Diagram of the head of *Bombus*, seen from the right. (1) Clypeus. (2) Labrum. (3) Mandible. cd = length of the malar space. ab/cd × 100 = Krüger's index.

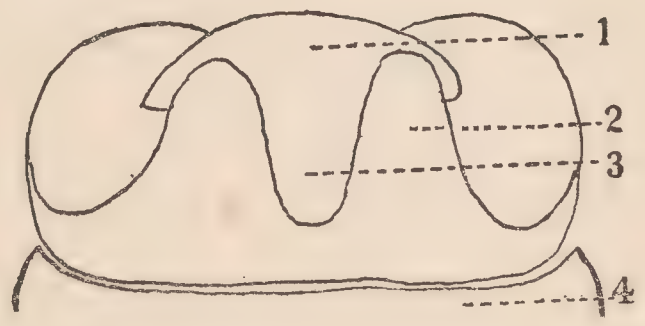

Fig. 2.—Diagram of the labrum of *Bombus terrestris*, L., female. (1) Lamella. (2) Tubercle. (3) Furrow. (4) Clypeus.

elaborate measurements that even geographical races may differ from one another in their proportions. Unfortunately it seems almost impossible to find really definite starting-points for the measurements. No doubt Krüger's measurements are all strictly comparable with one another, but it is very doubtful if measurements made by another worker, even of the same specimens, would be identical. For this reason measurements are practically omitted in the present paper. The proportions of the length to the breadth of the malar area (see text-fig. 1) are shown in the list (partly based on Krüger, 1920) on page 250, in which the species are arranged in order of length of the malar area; the more easily recognised species will afford fixed points in this scale.

The structure of the mandible in the female is very important, and Krüger has described it in full. Figure 1 shows the left mandible of *B. sylvarum*, L., the names of the parts being given in the Explanation of the Plates. The labrum of the female is also nearly always very specific, though the differences often consist only in small sculptural characters. These differences are found, as a rule, to be remarkably constant (text-fig. 2).

The mouth-parts are very uniform in the different species. The mentum, however, provides a character which differentiates all the species of *Bombus* (male and female) from those of *Psithyrus*. In species of the latter genus the mentum, seen from beneath, is deeply impressed at its apex with its sides strongly raised, while in *Bombus* it is convex with the sides scarcely raised. According to E. Saunders (1896) the possession of two-jointed maxillary palpi is a generic character of *Bombus* and *Psithyrus*. The number of joints, however, has been found, in fact, to vary within these genera, for the palps may be either two- or three-jointed; in some cases it is difficult to determine the real number of joints owing to the partial fusion of some of them. The shape of the joints also varies to some extent; over a hundred years ago Kirby (1802) separated *B. ruderarius*, Muell. (*derhamellus*, K.), from *B. lapidarius*, L., by the shape of their palps (see fig. 2).

2. *The thorax.*

The prosternum of humblebees is a remarkable structure. Most of the visible surface of the underside of the thorax is made up of the two propleurae which meet above the prosternum (fig. 3), and beneath which the prosternum has sunk inwards. The latter plate has a number of chitinous projections for muscle attachments, and of these, the processes marked A in figs. 4–6 always touch one another in *Bombus*, but are widely separated in *Psithyrus*. This difference is most easily seen in the females, but it can also be detected, in a lesser degree, in the males. In correlation with the stronger muscles of *Psithyrus* the prosternum is also more ridged and more strongly chitinised. In both genera these structures show certain specific differences, but these are hard to define.

3. *The legs.*

The structure of the intermediate metatarsus of the female divides the species of *Bombus* into two main groups. In one, the tarsus is spinosely produced at its external apical angle, while in the other, it is scarcely produced at all (fig. 7). Further, in some cases the length of the fringe of hairs on the male intermediate metatarsus varies specifically. In the female the hind legs show more differences. The hind femora have a specialised arrangement of hairs on the inside behind. First there is a brush of peculiar hairs at the apex on the posterior edge. These hairs are whitish and dilated at their tips, and there slightly emarginate. (Similar hairs occur on the inner surface of the posterior tibiae.) The rest of this surface of the femur is covered with long hairs except for certain bare spaces. The arrangement of these bare spaces, with the names given to them, is shown in text-figs. 3–5. The apical, extero-posterior angle of the hind tibiae is produced in some species of *Bombus*, rounded in others (see text-figs. 4 and 5). The arrangement of the bristles on the claw-joint of the tarsi is usually very constant and may provide good generic characters; yet in some species of *Psithyrus*, the fourth tarsal bristle (see fig. 8) is duplicated in a certain percentage of individuals. This is never the case in *Bombus*.

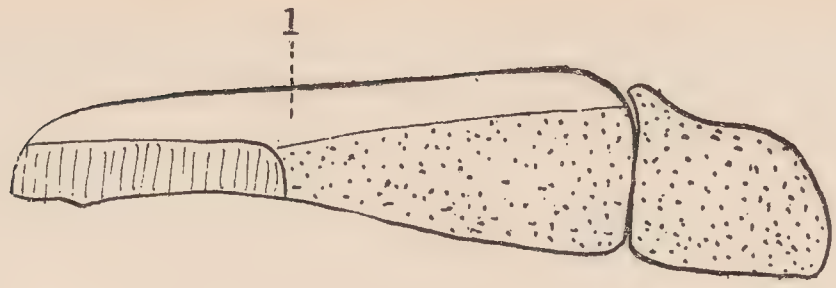

Fig. 3.—Intero-posterior surface of the left hind femur of *Psithyrus rupestris*, F., female. (The dots represent long hairs; the cross-hatching spathulate hairs.) (1) Anterior bare space, continuous to base.

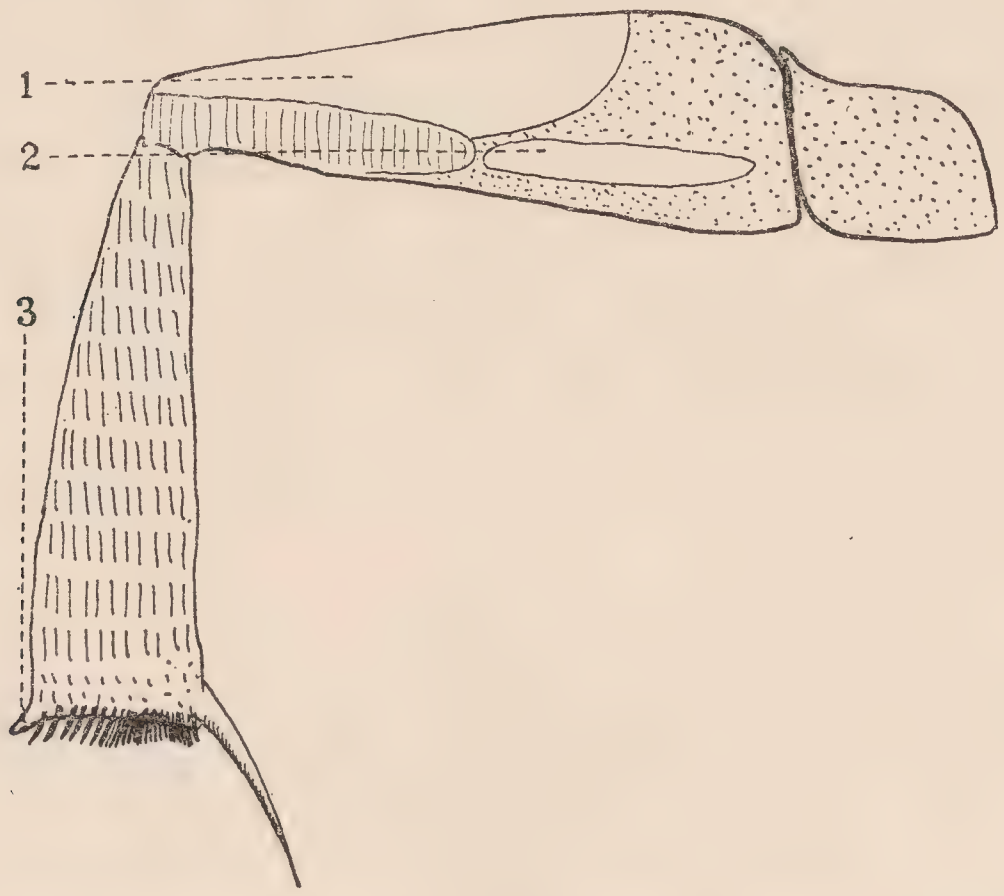

Fig. 4.—The same surface of left hind femur and tibia of *Bombus solstitialis*, Pz. (*helferanus*, Seidl.), female. (1) Anterior bare space. (2) Basal bare space. (3) Produced posterior angle of the tibia.

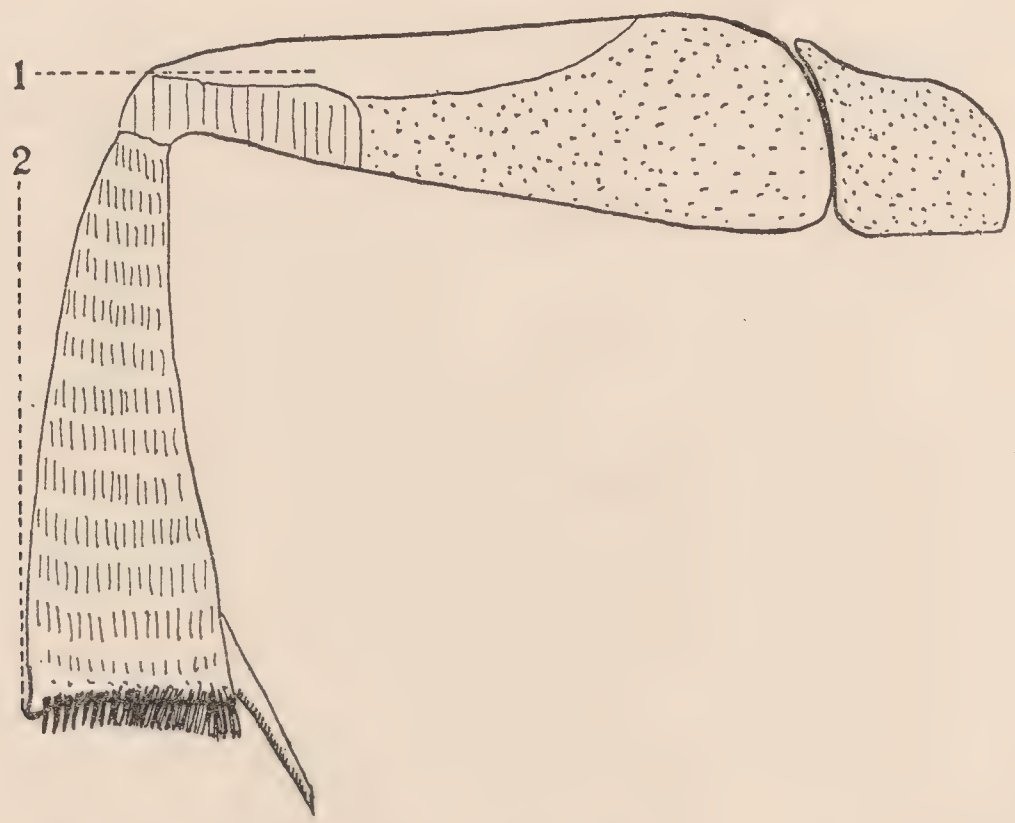

Fig. 5.—The same in *B. terrestris*, L., female. (1) Anterior bare space. (2) Posterior angle of the tibia not produced.

4. *The abdomen.*

As a preliminary to a discussion of specific characters, something must be said as to the manner of attachment of the arthrodial membranes between the segments. In figure 9, (*a*) shows the simplest type of attachment. In the abdominal segments of humblebees, however, the membrane becomes folded

as in (*b*), and fused on to the segment as in (*c*). Thus at the point marked (*x*) there is a raised line marking the limit of the fold, and this, in the present paper, is called the margin of the segment.

In all descriptions of the abdomen the segments are numbered, for convenience, as if the true first segment, the propodeum, was a part of the thorax.

In the first sternite specific characters are found in the arrangement and nature of the hair. Thus, in *B. terrestris*, L. (fig. 10), the long hairs spread right up to the lateral margins, while in *Ps. vestalis*, Fourcr. (fig. 11), they end before it. In the latter, also, there is a band of short, decumbent pubescence along the lateral margin. The size and definiteness of the basal depression also varies in different species.

At the base of the first sternite is a lamella, directed backwards (fig. 10). This can be seen in both sexes of *Bombus* (but cf. p. 240), but in *Psithyrus* the central part is completely fused to the main surface of the segment in all the females (fig. 11), though still recognisable by being destitute of hairs. In the males the degree of fusion varies, being complete in *Ps. rupestris*, F., and only partial in *Ps. vestalis*, Fourcr. In *Psithyrus*, further, the females have the first sternite much raised and thickened near the posterior margin, just before which the surface of the sternite drops perpendicularly. Similarly the second sternite is raised and thickened behind a line running across its centre. These modifications can be seen to a smaller extent in the males. In *Bombus* no species has the first sternite appreciably modified, and in only a few species is the second sternite somewhat thickened basally.

The second sternite usually has a lateral patch of decumbent pubescence, very conspicuous in the *agrorum*, F., group, but absent in some species. The long hairs, also, of this segment may spring from its whole surface (*Psithyrus*, etc.), or they may be absent from the patch of decumbent pubescence and from the area just behind it. In some species the sternites have a central line, along which the puncturation is finer or absent. Many species have some sort of apical callosity on the last visible sternite (*i.e.* male 6th, female 5th). These callosities are very marked in the females of *Psithyrus*, and here very specific in their shape.

The sting and the male genitalia and the segments modified in connection with them, call for special description.

5. *The sting.**

In the females, the abdomen, excluding the propodeum, has five visible unmodified plates. The other segments have been drawn into the abdomen in connection with the sting. It is not necessary here to consider the homologies of the parts to be described, and the names given to them will be non-committal in this respect. Figure 12 shows the extracted sting in its natural position, seen from the left; the spiracular plate (fig. 13) usually remains attached to the abdomen when the sting is extracted. This plate is connected by membranes to the fifth sternite and tergite and to the transverse line on the outer sting-plate.

The stings of the females of *Psithyrus* differ from those of *Bombus* in the following particulars: the whole sting is more highly chitinised (this applies also to the membranes attaching the sting to the abdomen, which are brown, instead of being transparent); the hairs on the sting-palp are much denser in

* Cholodkovsky (1884) first showed that specific differences occurred in the stings of humblebees; his work, however, has been neglected.

Psithyrus, and are always much branched; in *Bombus*, though some of the species have branched hairs, this is not usually the case with those hairs that spring from the highly chitinised part of the palp; in *Psithyrus* the projections from either side of the inner sting-plates are fused above the anus, while in *Bombus* they are only joined by membrane; the outer sting-plate in *Psithyrus* has an appendix (fig. 14).

In *Bombus*, the most useful specific characters are found in the shape of the inner projections from the sting-sheath (see figs. 46–58). Such projections are of simple shape in some species, but these may have isolated, chitinised areas (= *incrustationes vestibuli aculei*, Cholodkovsky, 1884) lying in the membrane between. In the species of *Psithyrus* the projections are quite simple; the only specific differences that have been found are slight variations in the proportions of the parts. Specific differences may also occur in the spiracular and outer sting-plates, but these are usually small and somewhat variable. For the actual identification of humblebees, the differences in the shapes of the inner projections of the sting-sheath are of most practical value; in a freshly extracted sting, they can be seen with a hand-lens, and, in some species, form the most ready means of recognition. If the sting has dried, it may be necessary to treat it with potash to remove hardened muscles. Much smaller differences are found in the stings of workers, and these will be mentioned under each species.

6. *The male genitalia.*

In the male there are seven dorsal and six ventral plates visible externally; the eighth tergite is membranous, except at its sides; the seventh and eighth sternites are hidden under the sixth, and their shapes are often very specific. The genitalia have often been described, but seldom accurately. A useful summary of the work on this subject is given by Boulangé (1924), and Krüger (1920) has figured each of the main types in *Bombus*. In the future it may be possible to homologise the genitalia of all male Hymenoptera with one another, but this is not possible at present. The names, therefore, given to the parts in the present paper are non-committal ones. The proximal part of the genitalia (see fig. 15) is a ring of chitin joined by membrane to the eighth dorsal and ventral plates; this is the *Cardo* (= *annular lamella* of ants, *sclérite accessoire* of saw-flies). The remainder of the genitalia is like a pair of forceps, the main part of the limb on each side being formed by the *Stipes* (= *pièce principal* of sawflies). At the apex of the stipes, firmly fastened but not fused to it, is a small dorsal plate, the *Squama*. The *Volsella* (or *Lacinia*) is a piece attached to the intero-ventral surface of the stipes. Amongst the sawflies the volsella is represented by two articulated plates, which, in the opinion of Boulangé, are fused in *Bombus*. This theory is probably correct, though in *B. subterraneus*, L. (*latreillellus*, K.), there are traces of a second plate proximal to the volsella.

Between the forceps lies the *Penis*, which is essentially a tube with three of its walls highly chitinised. The dorsal plate is called the *Spatha* and the two lateral the *Sagittae*.

Practically every part of the genitalia is liable to be specifically differentiated, and the structures found have, in fact, been so diverse that it has been difficult to discover characters indicating relationship amongst species not very closely allied. The following characters, however, will divide the species into groups which seem natural when other characters are considered. Figures 16 and 17, 18 and 19, respectively, show the penis of two species, *B. terrestris*, L., and *B. agrorum*, F., disarticulated from the rest of the genitalia. Figures 19 and 17,

respectively, show how the keel, starting from the base of the spatha, does or does not project over the fused bases of the sagittae. Species with the *terrestris*-type of genitalia have the spatha broad at the base (see fig. 16), and this leads to a further difference between the two types. In the *agrorum*-type (fig. 17) the inner margin of the sagitta runs straight into the outer margin of the spatha; in the *terrestris*-type (fig. 16) the broad base of the spatha overlaps the junction between its outer margin and the inner one of the sagitta, so that this junction can be seen only by transparency through the spatha. In *Psithyrus* (fig. 20) the spatha is of the *agrorum*-type, but there is no keel along the fused bases of the sagittae. In forms of the *agrorum*-type, the squama is more or less produced inwards in the form of a lamella or spine (see figs. 25–32). A similar spine occurs in *Psithyrus*, but not, at any rate fully developed, in other *Bombi*.

The seventh and eighth sternites are usually of a special type for each species, but those of the *agrorum*-type have the basal projection of the eighth sternite narrow, while it is broad in those of the *terrestris*-type. Figures 21 and 22 also show the extremes in the shape of this sternite, while figures 23 and 24 show the two types of hair-tuft which may occur at the apex of the seventh.

The full structure of the male genitalia can only be seen after treatment with potash, dehydration and clearing with xylol. This treatment is necessary for a study aiming at deciding the relationships of the species, but for mere identification the untreated genitalia need only be examined with a hand-lens.

III. The Subgenera of *Bombus*.

Vogt (1911) first divided *Bombus* into subgenera on the characters of the genitalia. His work has been amplified considerably by Krüger (1920), who divided the genus into two primary divisions, (1) *Odontobombus* and (2) *Anodontobombus*, which are characterised as follows:—

(1) Female with a long head, postero-exterior angle of the intermediate metatarsus produced into a spine, hind metatarsus also spinosely produced and emarginate at the apex; mandibles usually with a basal keel. Male squama with a transverse lamella projecting on the inner side; flagellum of the antennae elongate with the joints more or less bent and, in many species, more or less thickened.

(2) Female as a rule with a short head and short cheeks (exception *B. mendax*, Gerst.); no spine at the apex of the intermediate metatarsus (except *B. mastrucatus*, Gerst.), hind metatarsus not spinose, the apical edge not being emarginate; mandibles usually with a basal keel. Male with no transverse lamella on the squama, though sometimes with a relatively small projection. Flagellum usually short, the joints not bent.

According to Sladen (1912), those species of the first group that have been examined store pollen in cells intermingled with the brood, while those in the second group store it in special cells apart from the brood.

The second group, it will be seen, is mainly characterised by the absence of special structures. In my opinion this group has no subgeneric value, since it cannot be maintained that all the species in it are more closely allied to one another than they are to species in other groups. On the other hand, Vogt (1911), Ball (1914), Krüger (1920) and Skorikov (1922) have between them built up a number of subgenera, mainly on the structure of the genitalia, that have a real value, for it is certain that the members of these groups are really more closely allied to one another than to any other species.

The characters in which these subgenera differ will be found in the key on pages 241–7.

Some of the subgenera are capable of being grouped together because they are evidently allied to one another. Thus *B. lapidarius*, L., *B. mastrucatus*, Gerst., *B. cullumanus*, K., and the *B. pratorum*, L., group are all really fairly closely allied, and Vogt (in Krüger, 1920, p. 461), indeed, has included all except the second in a group, *Uncobombus*. This is characterised by having the sagitta in the male hooked, the hook turned inwards, and by having isolated chitinised areas in the membrane between the inner projections of the sting-sheath of the female. I suspect that if all the Holarctic *Bombi* were compared the four subgenera would have to be combined into one, defined mainly on the characters mentioned above. *B. mastrucatus*, Gerst., has been supposed to be a very distinct species retaining some ancestral characters. Its peculiar mandibles, however, are probably correlated with its habit of biting through the corolla of flowers, a habit which is certainly not primitive, while nearly all its other characters link it with *Uncobombus*. The spinose intermediate metatarus seems to me to be a character which might easily be acquired independently. Such small structural differences are of value in determining affinities only when a number of them are correlated. In the same way the ratio of the length of the clypeus, malar area, etc., to their breadth, are characters of value only when taken in conjunction with others; for though such characters might often arise independently, yet it is unlikely that many of them would so appear in company.

The species *B. confusus*, Schenck, and *B. mendax*, Gerst., provide a very good example of the impossibility, in many cases, of arriving at any certainty by the methods of comparative anatomy. They have each been placed in a monotypic subgenus, but, though they differ in a number of characters, they share certain peculiarities, some of which are not found in other species of *Bombus*. Thus in the females the main keel of the mandibles ends abruptly before reaching the margin; the sulcus obliquus is not developed; the hind femur has no dorsal bare space; the basal lamella of the first sternite is more or less fused to the main surface of the sternite, at any rate in the centre, as in *Psithyrus*. In the male, the eyes are much larger than those of the female, this character being correlated, in all probability, with the peculiar Syrphid-like flight: the intero-posterior surface of the hind femora is hairy all over; the seventh sternite is very narrow in both species and the basal process of the eighth very wide; the spatha of the genitalia projects very strongly behind, but in a blunt projection not in a point, as in *B. terrestris*, L. Vogt (quoted in Krüger, 1920, p. 460), has suggested the name *Sulcobombus* for these two species. Unfortunately, however, they have so many points of difference that it is very uncertain if they are really related at all closely. The hind tibia of the female in *confusus* has a well-marked basal space, while in *mendax* there is none; in the first-named species, also, the long hairs of the first sternite go right up to the lateral margin, while in *mendax* they stop some way before it; the stings are quite different, that of *confusus* somewhat resembling an *Uncobombus*, while *mendax* has a very simple sting, just like a *Psithyrus*. The male genitalia, in characters other than the spatha, are entirely different, each species belonging to a very distinct type. It is impossible to say what weight should be given to the resemblances and differences respectively; until fresh evidence is brought forward, it will be best to keep them in separate subgenera.

The following key to the species of *Bombus* is designed to show their relationships as well to help in their identification. The latter, indeed, soon

becomes easy with a little practice, except for relatively rare deceptive colour-variations.

IV. A Key to the British Species of *Bombus*.

The *males* are known from the *females* by their 13-jointed antennae, their simple labrum, densely haired clypeus, and more slender legs and abdomen, as well as by their primary sexual characters.

A. *Females*.

1. (22) Intermediate metatarsus produced into a spine. Mandibles with a basal keel and a sulcus obliquus. Maxillary palps two-jointed, the second joint widened towards the apex. The hair band of the first sternite not reaching the lateral margin. The long hairs at the sides of the second sternite springing from the posterior margin only . . . . . *Odontobombus*, Krüger.
2. (5) Head, malar space and tongue exceptionally long. Lamella of the labrum only about one-third as broad as the labrum and with a curved edge, labral furrow narrow. Last visible tergite with only short black hairs. Outer projections of the sting-sheath not very broad ventrally and with a black chitinised spot distal to them; inner projections with two black, chitinised spots . *Hortobombus*, Vogt.
3. (4) Colour lighter. Coat more shaggy. Size smaller. Head and malar space very slightly longer. Lateral tubercles of the labrum less punctured. Anterior thoracic band broader than the posterior one. *hortorum*, L.
4. (3) Colour darker (sometimes all dark). Coat more even. Size larger. Head and malar space a little shorter. Labral tubercles more punctured. The yellow thoracic bands of the same width. *ruderatus*, F
5. (2) Head, malar space and tongue less elongate. Lamella and furrow of labrum both broader. Sting with a different structure.
6. (9) The hair-band of the first sternite connected with the margin by a broad band of decumbent pubescence. Sixth sternite with a strong keel. Sting-sheath with heavily chitinised, rounded inner projections, and two folds in the membrane between them; outer projections not broad ventrally. Lamella of labrum about half as broad as the labrum, the furrow very strongly widened towards the base. *Subterraneobombus*, Vogt.
7. (8) Colour ochreous with a black band between the wings. Size smaller. Coat somewhat longer and denser . . . . . *distinguendus*, Mor.
8. (7) Colour black with a whitish tail and a more or less marked, yellow, anterior and posterior thoracic band. Coat very short and even. *subterraneus*, L. (*latreillellus*, K.).
9. (6) Often no decumbent pubescence between the hair-band and the margin of the first sternite. Sting differently formed. Sixth sternite with never more than a slight apical keel. Lamella of labrum about two-thirds as wide as the labrum, and with its edge quite straight; labral furrow narrower.
10. (13) Head elongate. Posterior femur with a marked bare basal space. A little decumbent pubescence at the apex of the margin of the first sternite. Outer projections of the sting-sheath not broad ventrally. Thorax all black or with a well-defined black band. *Pomobombus*, Vogt.
11. (12) Colour yellowish-grey, tail faintly red-tinged; thorax with a black

band between the wings. Head slightly longer. Coat longer. Probably not a British species . . . . . *elegans*, Seidl.

12. (11) Colour black with a red tail, the red passing gradually into the black. Head slightly shorter. Coat shorter . . . . . *pomorum*, Pz.

13. (10) Head less elongate. Posterior femur sometimes without a bare basal space. The outer projections of the sting-sheath broad ventrally: very broad in species at all resembling the two preceding in colour. *Agrobombus*, Vogt.

14. (17) The inner projections of the sting-sheath very broad and almost meeting one another; the outer projections also very broad. Thorax all black or with a well-defined black band between the wings; some of the hairs of the tail reddish.

15. (16) Thorax usually yellowish-grey with a black band between the wings; abdomen yellowish-grey with white and reddish hairs in the tail (in a rare variety the colour is as in the following species). Lamella of the labrum with a knife-like edge. Bare basal space of the posterior femur more marked. The shining unpunctured central line of the abdominal sternites more marked . . . . . *sylvarum*, L.

16. (15) Colour black with a red tail; posterior tibiae with red hairs. Lamella of the labrum with its apical margin thickened. Bare space of the posterior femora not distinguishable. The shining unpunctured central line of the abdominal sternites less marked. *ruderarius*, Muell. (*derhamellus*, K.).

17. (14) The inner and outer projections of the sting-sheath much narrower. The thorax usually brownish-yellow, never more than irregularly mixed with black.

18. (21) Inner projections of the sting-sheath broader. Furrow of labrum ill-defined and broadened towards the base. A small patch of decumbent pubescence connects the hair-band of the first sternite with the margin. Practically no black hairs on the thorax and none on the abdomen above. Corbicular hairs usually pale. Coat more even. The projecting part of the domed membrane not strongly chitinised.

19. (20) Hair slightly longer. Malar space shorter. Band of darker, brownish-yellow hairs on the second tergite not marked. (In the Scilly and Shetland races the thorax is deeper orange-brown and the face, tibiae and abdominal sternites have black hairs.) The ventral end of the inner projection of the sting-sheath simple. *muscorum*, F.

20. (19) Hair slightly shorter. Malar space slightly longer. The darker band on the second tergite usually well-marked. The ventral end of the inner projection of the sting-sheath bifid. *solstitialis*, Pz. (*helferanus*, Seidl., *venustus*, E. Saund.).

21. (18) The inner projections of the sting-sheath narrower; the projecting part of the domed membrane of the sting black, strongly chitinised. The furrow of the labrum narrowed and well-defined towards the base. No decumbent pubescence at the margin of the first sternite. Malar space as in the preceding species. Often some dark hairs on the thorax and always some on the abdomen (at any rate at the sides of the second tergite). Corbicular hairs black. Coat longer and more shaggy . . . . . *agrorum*, F.

22. (1) The intermediate metatarsus not produced into a spine. Maxillary palps two- or three-jointed, the joints after the first parallel-sided. The hair-band of the first sternite produced to the margin except in one species. Lamella of the labrum always narrow and curved.

23. (24) Hair-band of the first sternite not reaching the margin but connected

with it by a more or less evident band of decumbent pubescence. The long hairs of the second sternite spring only from the hind margin. Mandibles without an incisura lateralis. The inner projections of the sting-sheath simple and strongly chitinised.
Soroënsibombus, Vogt., *soroënsis*, F.

24. (23) Hair-band of the first sternite continued to the margin. The inner projections of the sting-sheath are of a peculiar shape, or else there are isolated, chitinised thickenings in the membrane between them.
25. (28) The inner projections of the sting-sheath strongly chitinised and each one twice emarginate; no thickenings in the intervening membrane. Mandibles with a fairly strong sulcus obliquus and a marked incisura lateralis. The long hairs at the side of the second abdominal sternite spring from the whole surface (in specimens in good condition). Malar space and tongue very short . . *Bombus*, Latr. s.s.
26. (27) Size usually smaller; size of sting, as measured by the width of the outer sting-plate (fig. 60), always smaller. Sting less chitinised; outer projections of the sting-sheath usually wider ventrally. Coat somewhat longer. Colours paler, the tail being white . *lucorum*, L.
27. (26) Size larger; the sting larger and usually more strongly chitinised. Outer projections of the sting-sheath usually narrower ventrally. Coat somewhat shorter. Colours darker, the tail being buff.
terrestris, L.
28. (25) The inner projections of the sting-sheath simple, but the intervening membrane with isolated chitinised thickenings. The long hairs at the sides of the second sternite spring from the hind margin only.
Uncobombus, Vogt.
29. (32) Mandibles with a sulcus obliquus well-developed but without an incisura lateralis.
30. (31) Malar space longer. Clypeus flatter and not much impressed at each side at the apex. Tubercles of the labrum flat, little punctured but strongly alutaceous. Labral furrow deeper and better defined. Outer side of the hind metatarsus with dense, short, yellowish hairs. Last visible tergite somewhat convex centrally. Inner projections of the sting-sheath fairly broad, the intervening membrane thrown into two longitudinal folds the inner edges of which are rather strongly chitinised. Colour black with a red tail, the tibial hairs black; wings hyaline. A very common species.
Lapidariobombus, Vogt, *lapidarius*, L.
31. (30) Malar space shorter. Clypeus more convex and more impressed at each side at the apex. Labral tubercles convex, strongly punctured, shining and not alutaceous; labral furrow less deep and less clearly defined. Outerside of hind metatarsus with quite sparse hairs, and so appearing shining black. Last visible tergite with an impressed central line. Inner projections of the sting-sheath rather strongly produced inwards dorsally, two small, isolated, chitinised spots being situated near these dilatations. Colour as in the preceding, but wings with a dark apical band. Very local species (Chilterns, S. Downs and Suffolk) . . *Cullumanobombus*, Vogt., *cullumanus*, K.
32. (29) Mandibles with no sulcus obliquus, but with a fairly strong incisura lateralis. Thickenings in the membrane of the sting-sheath very strong . . . . . *Pratobombus*, Vogt.
33. (34) Disc of clypeus strongly punctured. Malar space longer than in *jonellus*, usually slightly shorter than *pratorum*. Tergites two to five with red hairs. Sting and stigmatic plate like that of *B. jonellus*, K. Found in the Vaccinium-zone on mountains in the West and North . . . . . *lapponicus*, F.

34. (33) Disc of clypeus hardly punctured, shining.
35. (36) Malar space shorter. The thickenings in the sting-membrane nearly always much larger and more strongly chitinised. Dorsal process of stigmatic plate less produced. Coat shorter and more even. Colour black, with a white tail, and with yellow anterior and posterior thoracic bands and one on the first tergite. Species practically restricted to heaths . . . . . *jonellus*, K.
36. (35) Malar space longer. The thickenings in the sting-membrane smaller and less chitinised. Dorsal process of the stigmatic plate very strongly produced, parallel-sided (fig. 59). Coat longer and more uneven. Colour black, with a red tail (the red not including more than the last three tergites), and a yellow anterior thoracic band, and usually also one on the second abdominal tergite. Found in woods and cultivated land . . . . . *pratorum*, L.

B. *Males.*

1. (22) Maxillary palps two-jointed, the second joint usually somewhat club-shaped. Antennae long with the individual joints slightly bent. Hair-band of the first sternite not reaching the margin, though nearly so in *Subterraneobombus*, Vogt. The long hairs of the sides of the second sternite springing from the hind margin only. The seventh sternite not emarginate at its apex. Basal process of the eighth sternite not much wider than long and usually narrower than long. Spatha of the genitalia narrow at the base, and produced anteriorly into keel, which projects as a hook-like tooth over the fused bases of the sagittae. Squama produced inwardly into a large lamella or spine . . . . . *Odontobombus*, Krüger.
2. (5) Head, malar space and tongue very long. Mandibles with a beard. The third antennal joint longer than the fifth. Sagitta of the genitalia rod-like and serrate beneath. Lamella of the squama curved backwards and ending in a dorsal and a ventral point. Volsella with a hook-like tooth at the tip, otherwise simple. Hairs of the face black. . . . . *Hortobombus*, Vogt.
3. (4) Coat longer and more uneven. The yellow and black of the thorax less sharply marked off; melanic forms infrequent . *hortorum*, L.
4. (3) Coat shorter and more even. The black and yellow of the thorax more sharply marked off; melanic forms frequent . . *ruderatus*, F.
5. (2) Head, malar space and tongue shorter. Third antennal joint not longer than the fifth. Sagitta of the genitalia quite different except in *B. agrorum*, F., which has the thorax mainly yellow-brown. Lamella of the squama quite differently formed.
6. (9) Mandibles without a beard. Posterior tibiae convex and hairy, almost as in *Psithyrus*. Seventh sternite produced into triangular apical process. Apical hair-tuft of the eighth sternite small and divided into two patches. Sagittae of the genitalia widened into a strong tooth at the apex, and also toothed in the middle beneath. Volsella very hairy on the inside towards the base, produced into a hook-like tooth at the apex, otherwise simple. Hairs of the face mainly black . . . . . *Pomobombus*, Vogt.
7. (8) Colour whitish-grey with a sharply defined black band between the wings . . . . . *elegans*, Seidl. (Doubtfully British.)
8. (7) Colour yellowish-grey and black intermixed, with most of the abdomen reddish . . . . . *pomorum*, Pz.
9. (6) Mandibles with a beard. Posterior tibiae sometimes convex, but never so hairy as in *Pomobombus*. Seventh sternite broadly crescentic or semicircular. Apical hair-tuft of the eighth sternite

very large and continuous. Sagittae of the genitalia often not broad in the dorso-ventral plane.

10. (13) Third antennal joint as long as the fifth or nearly. Posterior tibiae flat, shining, set with fairly close hairs. Sagittae of the genitalia broad at the base, with a lateral tooth before and at the apex. Volsella densely hairy interiorly towards the base, and with a hook-like tooth at the apex, otherwise simple . *Subterraneobombus*, Vogt.

11. (12) Third antennal joint as long as the fifth. Preapical process of sagitta tridentate (fig. 27*a*). Colour less bright; the black thoracic band ill-defined. The abdomen with always some black hairs. The hairs of the face mainly dark . . *subterraneus*, L. (*latreillellus*, K.).

12. (11) Third antennal joint somewhat shorter than the fifth. Preapical process of sagitta with only one marked angle (fig. 27*b*). Colour brighter; the black thoracic band better defined. No black hairs on the abdomen. The hairs of the face mainly pale.

distinguendus, Mor.

13. (10) Third antennal joint shorter than the fifth. Posterior tibiae convex, shining, with scattered hairs. Sagittae of the genitalia without a lateral tooth, though sometimes with a small ventral one, and with never more than a small tooth at the apex. Volsella with a tooth at the apex, another just before it, and a more or less strongly projecting rounded process towards the middle; volsella not specially hairy towards the base, but sometimes so on the rounded process. Hairs of the face pale, except in *B. ruderarius*, Muell.

Agrobombus, Vogt.

14. (17) The rounded process of the volsella very strongly projecting, the subapical tooth parallel-sided, but suddenly dilated at the apex. Thorax with at least a band between the wings black.

15. (16) Squama of the genitalia produced into a relatively long, narrow tooth and a small more posterior one. Sagittae not toothed beneath. Volsella with the rounded process densely hairy, the subapical tooth nearly square. Colour normally (when not like the next species) greyish-yellow with a black band between the wings and a pinkish tail . . . . . *sylvarum*, L.

16. (15) Squama of the genitalia produced into a relatively broad tooth. Sagittae toothed beneath before the apex. Volsella with the rounded process not specially hairy, and with the subapical tooth relatively narrow. Colour black, more or less intermixed with dark reddish brown and yellow, with the tail red.

ruderarius, Muell. (*derhamellus*, K.).

17. (14) Rounded process of the volsella not nearly so strongly projecting, its subapical tooth quite differently shaped. Thorax without much black.

18. (19) Individual joints of the antennae strongly swollen beneath towards the apex. Apex of the stipes of genitalia not much produced inwards. Sagittae simple, serrate beneath. Squama produced into a long, narrow curved tooth. Rounded process of the volsella densely hairy, its subapical tooth curved and pointed . . *agrorum*, F.

19. (18) The joints of the antennae not much swollen beneath. Sagittae of the genitalia hooked at their apex, not serrate beneath. Rounded process of the volsella not more hairy than the other parts.

20. (21) Apex of the stipes of the genitalia very strongly produced inwards. Sagittae slightly toothed beneath. Squama produced into a broad lamella which is bifid at its apex. Volsella with its subapical tooth bifid and its inner surface less hairy.

solstitialis, Pz. (*helferanus*, Seidl., *venustus*, E. Saund.).

21. (20) Apex of the stipes of the genitalia not very much produced inwards. Sagittae not toothed beneath. Squama produced into a simply pointed, narrower lamella. Volsella with its subapical tooth broadly triangular, and with its whole inner surface rather densely hairy . . . . . *muscorum*, F.

22. (1) Maxillary palps two- or three-jointed, the apical joints more parallel-sided. Antennae usually shorter and with the individual joints not bent. Hair-band of the first sternite reaching the margin. The long hairs of the second sternite arising from the whole or at any rate the greater part of the surface. Seventh sternite usually emarginate at its apex. Basal process of the eighth sternite at least twice as wide as long. Spatha of the genitalia broad at its base and produced anteriorly into a keel, which does not reach beyond the fused bases of the sagittae. Squama not produced inwardly into a large spine or lamella, rarely into a small one.

23. (24) Hind metatarsus considerably narrowed at its base. The third antennal joint about half as long as the fifth, the antennae very long. The seventh sternite emarginate at its apex. Squama very long, much longer than broad. Sagittae hooked at the apex, the hook turned outwards . . . *Soroënsibombus*, Vogt, *soroënsis*, F.

24. (23) Hind metatarsus not much narrowed at its base (slightly so in *cullumanus* and in exceptional forms of other species). Antennae not so long and the third joint equal to or longer than the fifth (except *cullumanus*). Squama not nearly so elongate. Sagittae not ending in an outwardly turned hook.

25. (28) Head and malar space very short. Third antennal joint equal to the fifth. Seventh sternite not apically emarginate. Squama produced into a small spine at its base on the inside. Sagittae very broad in the dorso-ventral plane. . . . . *Bombus*, Latr. s.s.

26. (27) Hairs of the face entirely or almost entirely black. Colours on the whole darker, the tail being more or less buff tinged. Size larger, the genitalia larger. The ventrally directed hook at the apex of the volsella usually broader . . . . . *terrestris*, L.

27. (26) Hairs of the face usually yellow. Colours on the whole lighter. Size on the average smaller, genitalia smaller. The ventrally directed hook at the apex of the volsella usually narrower.
lucorum, L.

28. (25) Seventh sternite apically emarginate. Squama of the genitalia not produced inwardly into a spine, though sometimes into a very small finger-like process. Sagittae not broad in the dorso-ventral plane, hooked at the apex, with the hook turned inwards.
Uncobombus, Vogt.

29. (32) Volsella of the genitalia reaching far beyond the squama. Squama with a small finger-shaped process on the inside at its base. The eighth sternite perforate, shaped like that of *B. terrestris*, L.

30. (31) Hind metatarsus not at all narrowed at its base. Third joint of the antennae somewhat longer than the fifth. Hair-patch of the eighth sternite smaller. Hook of the sagitta produced into a sharp point. Apex of the volsella emarginate . *Lapidariobombus*, Vogt, *lapidarius*, L.

31. (30) Hind metatarsus somewhat narrowed at its base. Third joint of the antennae much shorter than the fifth, the antennae longer than in the preceding. The hook of the sagittae of the genitalia rounded. The apex of the volsella not emarginate, the hairs on its inner side rather denser . . . . . *Cullumanobombus*, Vogt, *cullumanus*, K.

32. (29) Third antennal joint equal to the fifth in length. Hair-patch of the eighth sternite fairly large, the sternite not usually perforate, its

apex strongly produced as in *B. agrorum*, F. Volsella of the genitalia not reaching beyond the squama, its apex emarginate. *Pratobombus*, Vogt.

33. (34) Yellow and black species, with a white tail. Malar space shorter. Parapenial processes of the stipes of the genitalia narrower and more produced; the apex of the stipes usually strongly produced inwardly. Sagittae quite or nearly simple beneath. Species almost restricted to heaths . . . . . *jonellus*, K.

34. (33) Yellow and black species, with red tails. Malar space longer. Parapenial processes of the stipes of the genitalia wider, less produced.

35. (36) Abdomen with not more than the last four tergites with red hairs, the second tergite usually mainly with yellow ones. Apex of the stipes of the genitalia variable, but usually not much produced inwards. Usually no tooth on the underside of the sagittae; if the tooth is present it is beneath the middle of the sagitta. Species found mainly in woods and cultivated grounds . . . *pratorum*, L.

36. (35) Abdomen with the last four or five tergites with red or reddish hairs, and usually with no anterior yellow band. Apex of the stipes of the genitalia usually strongly produced inwards. The underside of the sagittae strongly emarginate beneath near the base, producing a tooth-like projection beneath, between the middle and the base. Apex of the volsella more strongly emarginate. Species found mainly in the Vaccinium-zone of mountains . . . *lapponicus*, F.

V. Notes on the Individual Species of *Bombus*.

The characters given in the key for the identification of the females apply to a large extent to the workers, but the differences are nearly always much smaller in degree; the sting, in particular, being in most species quite or nearly simple. The workers of *Uncobombus*, for instance, never have isolated chitinisations in the sting-membrane. In practice, the workers can generally be identified by colour and general appearance. The colour variation is not great enough, as a rule, in England to make this very difficult; doubtful identities can usually be settled by some of the structural characters.

1. *Hortobombus*, Vogt.

Male genitalia, fig. 25. Female sting, figs. 46–47.

The male genitalia and the sting of the female make this subgenus very distinct. The worker, whose sting-sheath has slight dorsal inner projections, is most easily known by the very long head. The two British species are best distinguished by the difference in the length and smoothness of their coats. In the south of England *B. hortorum*, L., is rarely at all melanic, while *B. ruderatus*, F., is nearly always more or less darkened; I do not know, however, how far this is the case in the north.

2. *Pomobombus*, Vogt. (= *Fervidobombus*, Skor.)

Male genitalia, fig. 26. Female sting, fig. 48.

B. elegans, Seidl., is extremely doubtfully British. Dr. R. C. L. Perkins (1921) records a specimen in the Bignell collection. It was unlabelled, but it may have been caught in Devonshire. Nothing seems to be known of *B. pomorum*, Pz., besides Smith's record from Deal of nearly seventy years ago.

The worker and, to a less extent, the female resemble the common *B. ruderarius*, Muell. (*derhamellus*, K.), but they differ from that species in their black corbicular hairs, in the longer cheeks and in the differently constructed labrum.

3. *Subterraneobombus*, Vogt.

Male genitalia, figs. 27–27*b*. Female sting, fig. 49.

As long ago as 1884 Saunders pointed out that the preapical process of the sagitta of the males of the two species of this subgenus differ constantly in their shape; all the specimens I have examined can also be separated by the proportions of the basal joints of the antennae. The females seem to me to be identical in structure, but in that sex the species are very sharply distinguished by colour. The workers, especially the larger examples, have their sting like that of the female and can easily be distinguished in this way from *B. ruderatus*, F.

Fleming (1926) has recently maintained that the species should be united, because he found a nest near Dresden in which, though the old queen and the workers were *subterraneus*, L., the queens which hatched out later were *distinguendus*, Mor. He suggests that the type of coloration of the adult may depend merely on the atmospheric conditions prevalent during the pupal period. I think it is much more probable that a queen *distinguendus* had invaded the nest, laid a few eggs, and had later been driven out. Such invasions by the queen of *distinguendus* have already been recorded by Lindhard (see the present paper, p. 261).

4. *Agrobombus*, Vogt.

Male genitalia, figs. 28–32. Female sting, figs. 50–53.

All the species have quite distinct male genitalia, but *B. ruderarius*, Muell. (*derhamellus*, K.), and *B. sylvarum*, L., form a little subgroup of their own. The females are structurally very similar, but the difference in the labrum, when once appreciated, readily separates them. I have not seen any of the dark form (*nigrescens*, Pér.) of *B. sylvarum*, L.; it may be assumed that it would be separable in the same way as the type. The workers have their stings like those of the female.

The other three species are all fairly easily recognised by the characters given in the key. The worker stings are more alike than those of their females.

5. *Soroënsibombus*, Vogt.

Male genitalia, fig. 33. Female sting, fig. 54.

The representative of this subgenus is a distinct and, in England, non-varying species. The sting of the worker is almost like that of the female, and the species can thus easily be distinguished from *B. terrestris*, L. If the sting has not been extracted, *soroënsis* may always be recognised by the fact that the depressions at the apex of the clypeus are relatively strongly punctured and are clearly separated from one another. In *terrestris*, the depressions are produced so far inwards that there is practically no impunctate space between them at the apical margin of the clypeus; the lamella of the labrum is also larger.

6. *Bombus*, Latr. s.s. (*Terrestribombus*, Vogt).

Male genitalia, figs. 15 and 34. Female sting, fig. 55.

The two species included here, though very distinct from any of the others, are still imperfectly understood. The difficulties will remain until a large

number of nest-fulls from different parts of their range have been examined, and the correlation between the characters of the male, female and worker have been properly ascertained.

The species are more distinct in England than they are in many parts of their range, for in this country *terrestris* occurs only in the race *audax*, Harris, which has the tail buff-coloured. In the workers, the buff colour rarely occupies more than a small band at the base of the white part of the tail. Probably all the workers with this buff band do belong to *terrestris*, but it is very doubtful if all the white-tailed specimens belong to *lucorum*. Much nest examination will be required to settle this question. The sting of the workers varies with the size of the insect; in a big specimen it may be almost like that of the female, while in the smallest workers there may be only one small emargination, forming a slight tooth-like projection, which at once separates them from *B. soroënsis*, F.

The females are more distinct than the workers, since in *terrestris* the whole tail is buff and there is a further difference in the general depth of colour. In addition to the difference in body-size there is a constant distinction in the size of the sting as measured by the width of the outer sting-plate (fig. 60). I have seen one female from Cornwall that seems to be intermediate between the two species in both size and colour.

In the males, the colour of the hairs of the clypeus is variable, though they are nearly always black in *terrestris*, and, more often than not, pale in *lucorum*. There is a marked difference in the size of the genitalia as measured by the length of the stipes (fig. 61). Indeed the genitalia can usually be separated according to size by the naked eye. The variations in the size of the genitalia do not seem to be correlated with body-size within each species. In *terrestris* male, the hind and mid metatarsus are somewhat broader, compared with their length, than they are in *lucorum*. There is also a slight difference in the most usual type of tip for the volsella for each species (fig. 34).

The following are the particulars of the measurements made :—

South of England.

1. Females.

	No. of specimens measured.	Outer sting-plate breadth.		
terrestris .	38.	Min. 1·86 mm.	Mean 2·00 mm.	Max. 2·22 mm.
lucorum .	37.	Min. 1·39 mm.	Mean 1·55 mm.	Max. 1·64 mm.

Two female *lucorum* from Brand, near Bludenz, S.W. Austria, both measured 1·56 mm. I have not been able to measure any females of *terrestris* from the continent.

2. Males.

	No. of specimens measured.	Stipes length.		
terrestris .	49.	Min. 2·05 mm.	Mean 2·17.	Max. 2·37 mm.
lucorum .	40.	Min. 1·80 mm.	Mean 1·93 mm.	Max. 2·00 mm.

Eight male *terrestris* from various parts of France agree with the English males. Five male *lucorum* from various French localities, 6 from Brand (S.W. Austria) and four from Seiser Alpe (Italian Tyrol) also come well within the size-range of the British specimens.

The measurements were all made with a Zeiss screw-eyepiece micrometer. Statistical examination of the measurements of the British specimens (by the method which makes allowance for the small numbers measured) shows that the differences are certainly significant.

7. *Lapidariobombus*, Vogt.

Male genitalia, fig. 35. Female sting, fig. 56.

The female of *B. lapidarius*, L. is very distinct by reason of her short, even coat. The worker is quite similar, except that the sting is simple. The tubercles of the labrum in the female are densely alutaceous, usually all over, but in the worker are only so in front.

8. *Cullumanobombus*, Vogt.

Male genitalia, fig. 36. Female sting, fig. 57.

The male of *B. cullumanus*, K., though connecting to a certain extent *Uncobombus* with *Soroënsibombus*, is quite distinct. The type (which is in the British Museum) and the three other British males whose genitalia I have examined, all differ from the figure given by Krüger (1920, plate 0, fig. 6). In the British specimens there is a small projection at the anterior inner corner of the squama, as in *B. lapidarius*, L. No such projection is figured by Krüger in his German specimens, and, if this is a real and constant difference, the continental forms will require a racial name. The British specimens differ amongst themselves, for one from Seaford (Sussex), kindly given me by Mr. E. B. Nevinson, has the posterior inner angle of the squama serrated (fig. 35 is not enough magnified to show this), as in Krüger's figure, while the type (from Suffolk) and two specimens from the Berkshire Downs lack this serration, that corner of the squama being produced into a single strong tooth. The Seaford specimen and the type both have the hairs on the inside of the volsella considerably more dense than in the Berkshire males. This species evidently requires further study, but it is possible that its very localised distribution has led to much race formation.

The female is very like *B. lapidarius*, L., but may be distinguished by the characters given in the key. I have seen one female from the Berkshire Downs. The supposed females in the British Museum, caught by F. Smith, are only *B. pratorum*, L. The worker, of which I have seen one specimen from near Tring (Bucks), agrees with the female, except that the sting-characters are less marked and that the wings are more evenly suffused. The labrum also is more like *lapidarius*. This specimen agrees structurally with some workers from Schleswig (in the British Museum), named by Friese, and also with Krüger's description (1920, p. 420 *et seq.*). The Schleswig specimens, however, have a faint greyish anterior thoracic band.

9. *Pratobombus*, Vogt.

Male genitalia, figs. 37–39. Female sting, figs. 58, 59.

The three species of this subgenus are distinct in colour and habits, as well as in structure. The stings of the females of *pratorum* can probably always be distinguished from those of *jonellus* and *lapponicus*, though there is some variation. The workers are much more alike, the stings being quite simple; they differ, however, in colour, habits and head proportions.

VI. The Proportions of the Malar Space in the Females of *Bombus*.

In the following list the species are arranged in order of length of the malar space, beginning with the longest. The arrangement is partly based on Krüger, who has made many accurate measurements of the part in question.

(1) *hortorum*, L., (2) *ruderatus*, F., (3) *elegans*, Seidl., (4) *pomorum*, Pz., (5) *distinguendus*, Mor., and *subterraneus*, L., (6) *solstitialis*, Pz., and *agrorum*, L., (7) *sylvarum*, L., (8) *ruderarius*, Muell., and *muscorum*, F., (9) *pratorum*, L., (10) *lapidarius*, L., (11) *lapponicus*, F., (12) *soroënsis*, F., and *cullumanus*, K., (13) *jonellus*, K., and *terrestris*, L., (14) *lucorum*, L. Owing to variation, species placed in adjacent classes (e.g. *pratorum* and *lapidarius*) may not be distinguishable in particular specimens.

VII. The Distinctions between *Bombus* and *Psithyrus*, with a Table of the Differences.

Most Hymenopterists have regarded *Bombus* and *Psithyrus* as very closely allied genera, hardly to be distinguished except by the loss of the pollen-collecting apparatus in the latter, in correlation with its parasitic mode of life. This view, however, is not at all correct. The European species of *Psithyrus* have a number of characters in common which they share with no species of *Bombus* and have many which are found only in certain *Bombus* species. In the following table of comparison, the characters are numbered to facilitate a discussion in Section X, p. 255.

Comparison of *Bombus* and *Psithyrus*.

No.	*Psithyrus*.	Sex.	*Bombus*.
1.	The hairs of the face black.	Male.	Often pale.
2.	Mandibles obliquely truncate at the apex, sometimes nearly pointed.	Female.	Mandibles transversely truncate.
3.	Mandibles without a basal keel, but with a strong sulcus obliquus.	Female.	Mandibles sometimes with a basal keel, sometimes without a sulcus obliquus.
4.	Jaw-muscles more powerful.	Female.	Less powerful.
5.	Mentum deeply impressed and strongly margined beneath.	M. and F.	Mentum not impressed and margined.
6.	Head, seen from above, squarer.	M. and F.	More transverse.
7.	Head more firmly fastened to the thorax.	M. and F.	Less firmly.
8.	Antennae thicker.	M. and F.	Thinner.
9.	Processes of the prosternum widely separated (less so in the male).	M. and F.	Processes of the prosternum touching one another.
10.	Wings darker.	Female.	Wings not so dark.
11.	Intermediate metatarsi spinosely produced.	Female.	Metatarsi sometimes not so produced.
12.	Posterior tibiae convex and hairy on the outside, with no apical comb on the inside.	Female.	Tibiae concave, bare and shining on the outside, with an apical comb.
13.	Posterior metatarsi without an auricle at their base, strongly produced at their external apical angle.	Female.	Metatarsi with an auricle; sometimes not spinosely produced, never so strongly.
14.	Intermediate metatarsi with a fringe of long hairs at least twice as long as the tarsus is broad.	Male.	Fringe never more than $1\frac{1}{2}$ times as broad as the tarsus, often much shorter.
15.	Posterior tibiae, on the outside, convex, dull and hairy, the hairs mostly branched.	Male.	Posterior tibiae rarely convex; if hairy, none of the hairs on the disc are branched.
16.	Last joint of the tarsi sometimes with two fourth tarsal bristles.	M. and F.	Never with two fourth tarsals.

No.	*Psithyrus*.	Sex.	*Bombus*.
17.	Anterior bare space on the posterior femora reaches right up to the base.	M. and F.	The bare space stops before the base, often long before.
18.	Basal projection of the first sternite quite or partially fused with the surface of the sternite.	M. and F.	Very rarely fused. (*B. confusus* and *B. mendax*.)
19.	Hind margin of the first sternite and centre of the second transversely raised.	M. and F.	First sternite simple; second often simple, never so strongly raised.
20.	No long hairs on the first sternite near the lateral margin.	M. and F.	Long hairs may spring from the extreme edge of the sternite.
21.	A lateral band of decumbent pubescence at the sides of the first sternite.	M. and F.	This band usually absent.
22.	The long hairs at the sides of the second sternite spring from the whole surface.	M. and F.	Sometimes springing only from in front of the lateral band of decumbent pubescence.
23.	Last visible tergite usually without any long hairs.	Female.	Last tergite usually with long hairs.
24.	Last visible sternite with strong callosities; apex of the abdomen more or less incurved.	Female.	No callosities; abdomen not incurved.
25.	Last visible sternite and tergite fit together, so as to form a perfect overlapping joint.	Female.	Not so fitting.
26.	Whole sting more strongly chitinised.	Female.	Less chitinised.
27.	Sting palps usually densely hairy; the hairs on the chitinised part strongly branched.	Female.	Sting palps less hairy; the hairs less branched, those on the chitinised part rarely so.
28.	The outer sting-plate with an appendix.	Female.	Without an appendix.
29.	Inner sting-plates fused together above the anus.	Female.	Not fused but joined by membrane.
30.	Sting-sheath with the inner projections narrow and uniform.	Female.	Projections often specialised.
31.	Seventh sternite widely membranous at its apex, with a central, more chitinised area projecting into the membrane.	Male.	Seventh sternite not widely membranous at its apex.
32.	Eighth sternite with the basal process very narrow; apex of the sternite strongly produced, the lateral wings very narrow.	Male.	These characters often absent.
33.	Spatha widely rounded basally, not or scarcely produced into a keel.	Male.	Spatha usually basally produced into a point and usually basally keeled.
34.	Squama produced inwards into a lamella or spine.	Male.	Sometimes not so produced.
35.	Squama and apical part of the volsella submembranous.	Male.	Strongly chitinised.
36.	Hum low.	Female.	Hum much louder and often higher pitched.
37.	Male with a very strong aromatic scent.	Male.	Scent much less strong.
38.	Parasitic and without a worker caste.	Female.	Industrious, with a worker caste.

VIII. A Key to the British Species of *Psithyrus*.

The *males* are very different from the *females* in being much smaller (except *sylvestris*) and more slenderly built. The antennae are thirteen-jointed and the labrum is nearly simple.

A. *Females.*

1. (4) Main keel of the mandible well developed and reaching the margin. Malar space closely punctured. Scape of antennae shining. Hind metatarsus somewhat long and narrow. Last visible tergite dull and closely punctured, sometimes with long hairs at the sides.
2. (3) Colour black with a red tail and very dark wings. Tubercles and lamella of the labrum fused into one large triangular callosity. Clypeus densely punctured all over. Third antennal joint longer than the fifth. Last visible sternite produced into strong triangular lobes at the sides, these lobes being visible from above. Last visible tergite with some long hairs at the sides . . *rupestris*, Fab.
3. (2) Colour black with a white tail and yellow anterior and posterior thoracic bands, and sometimes one at the base of the abdomen. Tubercles and lamella of the labrum, though much thickened, quite distinguishable. Clypeus with a broad, smooth, shining central space. Third antennal joint as long as the fifth. No long hairs at the sides of the last visible tergite. Last visible sternite produced into lobes which, taken together, form a semicircle, not visible from above . . . . . *barbutellus*, K.
4. (1) The main keel of the mandible more or less narrowed or interrupted before reaching the margin. Last visible tergite shining, especially towards the base, less closely punctured, with no long hairs. The callose lobes of the last visible sternite always converging at a more or less acute angle. Tail never entirely red.
5. (6) Main keel of the mandible usually reaching the margin, but much narrowed just before it. Tubercles of the labrum not very large. Clypeus shining, not very closely punctured. Third antennal joint very slightly longer than the fifth; scape of the antennae very strongly shining. Hind metatarsus more narrow than in any other species. Tail much incurved, with the callosities rather small; extreme apex of the last visible sternite produced into a sharp point. *sylvestris*, Lep. (*quadricolor*, Auctt. nec Lep.).
6. (5) Main keel of the mandibles not reaching the margin. Tubercles of the labrum very strongly developed, forming blunt projecting teeth. Clypeus closely punctured, except at the apex in some specimens. Scape of the antennae dull. Hind metatarsus rather broad. Tail not so much incurved, callosities more developed, last visible sternite not produced into a spine.
7. (8) Main keel of the mandibles easily distinguishable, though short. Malar space less punctured than in any other species. Third antennal joint about as long as the fifth. Lateral disc of the first sternite almost entirely covered with decumbent pubescence. Abdominal tergites very shining. No white hairs amongst those of the tail. *campestris*, Pz.
8. (7) Main keel of the mandibles hardly developed at all. Lateral disc of the first sternite with a large bare shining space. Abdominal tergites much less shining. The hairs of the tail are usually mainly white.
9. (10) Size larger. Third antennal joint as long as the fifth. Last tergite more strongly punctured at the sides and apex. Coat shorter and

more even; colours darker, the white of the tail preceded on each side by a patch of bright lemon yellow . . . . . *vestalis*, Fourcr.

10. (9) Size smaller. Third antennal joint slightly longer than the fifth. Coat longer and more uneven; colours paler, the white of the tail being preceded on each side by a patch of pale yellow (soon fading to white) . . . . . *bohemicus*, Seidl. (*distinctus*, Pérez).

B. *Males.*

1. (2) Malar space shining with few punctures or hairs. Scape of the antennae more shining and with fewer hairs; the third joint very slightly shorter than the fifth, which is twice as long as the fourth. Last visible sternite with a trapezoidal callosity at its apex. Seventh sternite with two small hair-patches. Eighth sternite with the basal process longer than broad; sternite with only a minute perforation, and strongly produced, the production parallel-sided, rounded at its apex. Volsella basally produced into a conspicuous rounded lobe with a dense hair-tuft; volsella apically very narrow with a small hair-tuft at its tip. Sagitta toothed beneath in the middle. Tail normally white, passing at the extreme apex into black, then red (sometimes the tail is mainly yellow).

sylvestris, Lep. (*quadricolor*, Auctt. nec Lep.).

2. (1) Scape of the antennae not nearly so shining. Eighth sternite with its production becoming wider towards the apex, which is emarginate. Volsella without a definite, projecting, rounded basal lobe, not very narrow and tufted at the apex. The other characters not appearing together in any one species.

3. (4) Malar space with fine hairs, not very closely set, and with no large punctures. Third and fourth joints of the antennae together only a little longer than the third, and, therefore, much shorter than the fifth. Last visible sternite slightly callose at its apex. Seventh with two hair-patches at its apex. Eighth with the basal process longer than broad, the sternite with two or three perforations. Volsella at the apex finger-shaped but slightly pointed, its inner side anteriorly to the squama densely hairy. Sagitta not toothed beneath. Coat very short and even. The white of the tail preceded on each side by a patch of bright lemon-yellow . . . . . *vestalis*, Fourcr.

4. (3) Third and fourth antennal joints together considerably longer than the fifth, which is about as long as the third.

5. (6) Species structurally very like the preceding except that the eighth sternite is usually more deeply emarginate at its apex. The spatha is less widened towards its base. The inner edge of the squama usually more retreating and less densely hairy (though the exact shape and hairiness vary). The colours are paler, the yellow preceding the white of the tail being much paler (the tail may be entirely yellow); coat much more uneven and longer.

bohemicus, Seidl. (*distinctus*, Pérez).

6. (5) Malar space more strongly punctured. Eighth sternite with the basal process quadrate or broader than long, the sternite imperforate. Volsella, when finger-shaped, not pointed at its apex. Sagitta toothed beneath.

7. (8) Last visible sternite strongly callose at its apex, especially at each side. Seventh sternite with two hair-patches. Eighth with the basal projection broader than long. Volsella finger-shaped, with the apex completely rounded, its inner edge densely hairy basally. Inner edge of the squama not very hairy. Tail white . . . *barbutellus*, K.

8. (7) Last visible sternite only slightly callose at its apex. Eighth sternite with the basal projection quadrate. Volsella different in shape, not densely hairy towards the base. Inner edge of the squama densely hairy. Tail not white.
9 (10) Seventh sternite with two hair-tufts. Eighth sternite not very deeply emarginate at its apex. Volsella less broad towards its apex, the inner margin of the apical part concave. Squama strongly produced inwards and there ending in a tuft of curled hairs. Tail red; hairs of mid legs mainly red in front. . . . . *rupestris*, Fab.
10. (9) Seventh sternite with no hair tufts, at most one or two hairs. Eighth sternite very deeply emarginate at its apex. Volsella broader towards its apex, the inner margin of the apical part straight. Squama produced inwards, but without a tuft of curled hairs. Neither tail nor mid legs with red hairs . . . . . *campestris*, Pz.

IX. Notes on the Individual Species of *Psithyrus*.

Male genitalia, figs. 40–45; the shape of the semi-membranous squama is liable to variation and can only be seen clearly in carefully prepared specimens.

Ps. vestalis, Fourcr., and *Ps. bohemicus*, Seidl., are closely allied. The structural differences between them vary to some extent, but they may always be distinguished by the character of the coat, and the antennae in the male. For the nomenclature of *Ps. bohemicus*, Seidl. (= *distinctus*, Pérez), see Bluethgen (1918).

All the other British species are very distinct, and the genus could not be subdivided without making a subgenus for each species. The various structural characters are found in different combinations in each species; in the key it will be seen that species which seem to be allied in one sex, are often not closely allied in the other. Most species have some peculiar character which marks them sharply off from the others (*e.g.* the shining scape of *sylvestris*; the shining abdominal tergites of *campestris*; the peculiar apical callosities of the females of *rupestris* and *barbutellus*, etc., etc.).

The arrangement of the females in order of length of malar space is as follows, starting with the longest: *sylvestris*, *rupestris*, *barbutellus*, *campestris*, *bohemicus*, *vestalis*.

X. A Discussion of the Generic Characters of *Psithyrus*.

The first and most important fact about the parasitic humblebees is that of the 38 characters enumerated which are common to the five species (except No. 23), 27 are peculiar to *Psithyrus* (viz. Nos. 2, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 16, 17, 18, 19, 24, 25, 26, 27, 28, 29, 31, 33, 35, 36, 37, 38), and are found in no species of *Bombus*. No doubt some of these characters are necessary corollaries of one another, but the genus is, nevertheless, a well-characterised one. Some of the modifications of *Psithyrus* can, with great probability, be associated with the parasitic mode of life *; to illustrate this a brief summary must be given of the consequences of such a life in humblebees.

Sladen (1912) made a large number of observations on two species, *Ps.*

* In *Psithyrus vestalis*, Fourcr., and *Ps. barbutellus*, K., I have found that there are ten ovarioles in each ovary, whereas in *B. agrorum*, F., *B. lucorum*, L., and *B. pratorum*, L., there are only four; the poison-glands of the *Psithyri* were also much larger. I hope to examine these characters in other species.

vestalis, Fourcr., and *Ps. rupestris*, F., and he found that the female parasite has to invade the host-nest at an early stage, before its defenders have become too numerous. The host-female is sooner or later killed by the invader, and the parasitic-female has to be prepared to defend her eggs against the host-workers. Plath (1922) points out that in the species studied by Hoffer (1889) in Tyrol and by himself in America, the host-female is not usually killed, though the parasite has always to do some fighting, at any rate to intimidate the host-workers and to protect her eggs from them. Many of the *Psithyrus* characters could be interpreted as the result of the need for attack and defence. The pointed mandibles (2) may be partly for attack, but the truncate mandibles of *Bombus* are better instruments for dealing with wax, etc. Most parasitic ants (Wheeler, 1919) and many parasitic bees have their mandibles more pointed than those of their hosts. The stronger jaw-muscles and the squarer head, adapted to contain the bigger muscles (4 and 6), are evidently connected with attack; for this purpose, too, it is possible that the sting is more highly chitinised (26).

For defence there has been an increase in the extent of chitinisation, as in other parasitic Aculeates. In a general way this can be seen in the thicker integument and in the abdomen, where the intersegmental membranes are much reduced in *Psithyrus*, since much of what is membrane in *Bombus* is chitinised in the parasitic species. This allows breathing movements to be made without exposing the vulnerable membranes, and results in all the abdominal segments fitting more closely together. This condition may also, perhaps, be partly the result of an atrophy of the wax-glands, though I am not aware that any observation on the condition of the latter organs in *Psithyrus* has been recorded.

When an insect is attacked there are certain points of weakness even in the best-armoured species, viz. the anus and the connection of the head and thorax with the abdomen. It is one or other of these points of weakness that is pierced by those sand-wasps that prey on hard-bodied weevils or on bees. The anus, in female *Psithyrus*, is protected partly by the peculiar way in which the last visible sternite and tergite shut up like a box, the top overlapping the bottom (25), partly by the incurving of the tail and by the apical ventral callosities (24). Owing to the overlapping of the sclerites, a sting, to penetrate the junction of the thorax and the abdomen, must slide up the abdomen and enter the body of the victim in a plane parallel to the latter's ventral surface. In *Psithyrus*, the transverse keel of the second sternite and the raised and thickened hind margin of the first sternite (19) would probably tend to make this method of attack difficult. The incurving of the tail would be a further protection. The species with the most incurved tail (*sylvestris*) is also the one with the least developed transverse thickenings; these methods of defence seem, therefore, to be to some extent alternative.

The junction of the head and thorax is mainly vulnerable on the ventral side; if the head is forced upwards and backwards a wide area of membrane is exposed beneath. In *Psithyrus* this membrane is somewhat thickened, and the muscles pulling the head against the thorax are particularly powerful (7). Perhaps the special structure of the prosternum (9) is correlated with the more extensive musculature for this purpose. It is noteworthy that, in dead specimens, it is very difficult to remove the head from the thorax in *Psithyrus*; in nearly every case the prosternum comes away too, attached to the head.

Probably several characters in *Psithyrus* are secondary results of the general thickening of the integument, *e.g.* some or all of characters 16, 26, 28, 29. On

the other hand, the male genitalia are unusually membranous (35), perhaps in correlation with the more inflexible parts of the female.

The loss of the pollen-collecting apparatus (12 and 13) and of the worker caste (38) must also be connected with parasitism. The tongue does not seem to have been effected in the same way as the pollen-apparatus, since the bees still visit flowers for food, but it may be significant that the malar space of a female *Psithyrus* is always shorter, at least slightly, than that of its host. This probably means that the tongue is shorter, too, but the structure of the tongue of humblebees and its relation to the flowers visited, is a special and complex problem.

For the remaining characters of the genus *Psithyrus* (Nos. 5, 8, 14, 15, 17, 31, 33, 36) it is impossible, at present, to suggest any significance. With regard, however, to the structure of the male hind tibiae (15), it is probably often impossible for a part to be altered in one sex without some change being induced in the corresponding structure of the other sex. In this case the loss of the pollen-apparatus of the female seems to have led to a somewhat similar change in the male hind tibiae. Such a change is very likely a necessary result of the normal working of the mechanism of sex-inheritance.

The remaining characters of the table, though common to all the parasitic species, are also found in one or more species of *Bombus*. If any conclusion as to relationship were drawn from these structures, it would be that *Psithyrus* was allied to the section *Odontobombus*, since they agree in the following respects : the spinose intermediate metatarsi of the female; the first two sternites sometimes with indications of transverse thickenings (*e.g.* in *B. ruderarius*, Muell.); male and female with the area of long hairs on the first sternite not reaching the margin; basal projection of the male eighth sternite narrow; squama of the male genitalia strongly produced inwards. It is doubtful, however, whether these resemblances are significant.

XI. The Origin of *Psithyrus*.

This question has given rise to much speculation. No one, however, doubts that in some way *Psithyrus* has been derived from *Bombus*. Pérez (1883) considered that *Psithyrus* was monophyletic and supposed it to be derived from a form resembling *B. mastrucatus*, Gerst. His evidence for this derivation was very meagre, was based mainly on superficial resemblances, and is quite untenable.

Gaschott (1922) has made a comparison between the male genitalia of *Psithyrus* and of their hosts; he found that, while the genitalia of all the parasites share certain features in common, they none of them resemble the genitalia of their respective host-species. He concludes, therefore, that *Psithyrus* is monophyletic. His examination of the genitalia of the various species of *Bombus* led him to fix on *B. mendax*, Gerst., as the species most nearly resembling the probable ancestor of the parasites. This conclusion is based on the relatively simple form of the sagittae, squama and volsella in that species; he lays some stress on the fact that the hairs fringing the squama are branched in *Psithyrus* and also in *mendax*, though he admits that similar branched hairs are found in other *Bombi*. As a matter of fact, these hairs are branched in all *Bombi*, though the degree varies and in some species a high power of magnification may be needed to see the branching. In my opinion the genitalia of *Psithyrus* do not resemble those of *B. mendax* in any essential characters, nor is this relationship made much more probable by resemblances

in other structures. (On page 240 the discussion of *B. mendax*, Gerst., does reveal certain *Psithyrus*-like characters, unrecorded by Gaschott.)

Plath (1922) has recently suggested that the colour resemblances between the species of *Psithyrus* and their hosts are the result of genetic relationship; each parasite being thus derived directly from its host-species. He states that Franklin's division of the American species of *Psithyrus* into colour-groups also divides them according to the affinities of their hosts. At first sight, there is much to be said against this view. Gaschott's comparison of the genitalia does not support it, and the long list I have given in section 7, of characters common to all the species of *Psithyrus*, certainly seem to contradict it. It is noteworthy that there is no evidence that *Ps. sylvestris*, Lep., and *Ps. rupestris*, F., are more closely allied to one another than they are to other species of *Psithyrus*; yet their hosts, *B. pratorum*, L., and *B. lapidarius*, L., are certainly fairly close allies, and are much nearer to one another than is either of them to any of the other hosts of *Psithyrus*. These difficulties will be reconsidered in the next paragraph.

The most illuminating discussion of parasitism amongst Aculeate Hymenoptera is that of Wheeler (1919). He points out that a special type of parasitism occurs in these insects, for the host and parasite are always related to one another, often very closely. The immediate cause of parasitism, he suggests, is urgency of oviposition, combined with local or temporary lack of nest-building material, of nest-site or of larval food. Sporadic parasitism of this sort is well known; it is described, for instance, by Fabre (1914) in *Osmia* and by Bordage (1912) in *Pison* and *Trypoxylon*. Probably the attacks made by the queens of certain species of *Bombus* (see p. 261) upon nesting queens of other species of the same genus, whose nests they may usurp, are of the same nature. The real difficulty, however, as Fabre maintained, is to explain how such temporary or local habit could become permanent. Perhaps a clue to the solution may be found after a consideration of the characters of the parasitic Aculeates as a whole.

Sladen (1919) wrote a very interesting article comparing certain species of British bees with the almost identical species which represent them in Canada, amplifying his ideas by comparisons amongst the North American races of the same species. His general conclusion, in the eleven species examined (belonging to seven genera), was that the Canadian species were always smaller, shorter-haired, and with dingier, less pure coat colours. Within Canada, he found that, as the climate became warmer and drier, size on the whole was reduced, hairs became shorter, changing into tomentum, while the dark chitin (especially, also, in various sandwasps given as additional examples) tends to become paler, red or yellow markings appearing. These changes are associated with the usual temperature in early summer, the time when the larvae are developing.

Much additional evidence could be given supporting this correlation between a hot, continental climate and a certain type of coloration. The facts, unfortunately, are very scattered and it would take too much space to set them out in full; only a few striking examples can be given. Thus in the European *Polistes gallicus*, L., and in the European species of *Vespa*, specimens of southern origin can always be distinguished by the large amount of yellow on the thorax and abdomen. In various species of bees a dark race occurs in the north while a red-marked one is found in the south, e.g. *Prosopis variegata*, F., and *Andrena labialis*, K. These two bees are particularly interesting because of their parasites. The former, which is the only European species of its genus

to develop red markings, is parasitised by the only *Gasteruption* (*G. rubricans*, Guér.) that has extensive reddish markings (Stoeckhert, 1922). Similarly, while the dark northern form, *A. labialis*, K., has a dark parasite *Nomada cinnabarina*, Mor., var. *obscurata*, Schmied., the light southern race of the *Andrena*, *labiata*, Schenck, is the host of the light-coloured typical form of *N. cinnabarina*, Mor. (Alfken, 1913). In both these cases there is no question of mimicry, since the host and parasite are utterly unlike one another in their external appearance. In the Amanus Mts., in Asia Minor, Fahringer (Fahringer and Friese, 1921) found that a relatively large percentage of the species of *Andrena* had a red or partly red abdomen. In the more northern parts of Europe such forms gradually disappear as the climate becomes colder.

The importance in the present connection of this correlation between colour and climate lies in the fact that parasitic Aculeates as a whole have the same characteristics as southern races of industrious species. Wheeler (1919) and other authors have already pointed out that all parasitic species have a peculiar facies owing to the shortness of their coat, hairs frequently being replaced by tomentum or scales, and to the bright colours often assumed by their chitinous skeleton. I believe that darkening of the wings is also often associated with this type of coloration. It is possible that the special colour of parasitic bees and wasps is due to the fact that parasites tend to be developed from southern forms when at the northern edge of their range; this would also give a clue as to why temporary robbery or usurpation should turn into permanent parasitism. The southern species would always be working at a disadvantage compared with the more northern forms inhabiting the same district, especially in braving the weather, while there would be every opportunity for parasitism, since the northern species start their nesting activities earlier in the season. It is a fact that in various bees, including *Bombus* species, those of northern type nearly always start work early in the spring while the more southern ones start later, at any rate in the majority of individuals.

It may be suggested that the stigmata of parasitism might automatically be intensified by a parasitic mode of life. For the parasites would always develop later in the year than their hosts, and the sensitive pupa would thus always tend to be exposed to warmer weather in the parasites than in the hosts. This is evident in Aculeates which pupate in late summer, and, with or without leaving the nest, winter as adults. Those species which winter as larvae do not, as a rule, change to a pupa till shortly before the adult will emerge. The pupal period is thus short, and the sensitive period falls in the early summer or late spring when a few extra days or weeks may allow much improvement in the weather. It is unlikely, however, that even so the extreme colours of such forms as *Nomada* can be altogether explained in this way.

There are obviously great difficulties in accepting this idea, for not only is it very doubtful at present if such climatic effects are inherited, but it is difficult to see why the southern stamp should be so permanent. Harrison and Carter (1924) faced a very similar problem in their study of the races of the butterfly, *Aricia medon*, Esp. Here, apparently, cold had permanent effect. In spite of the great difficulties, I think no clue should be neglected in a problem which is still so obscure.

XII. Is the Genus *Psithyrus* Monophyletic?

Admitting that *Psithyrus* is to be derived from *Bombus*, one may attempt to answer this question by considering two classes of facts, viz. (1) the actual

degree of structural similarity between the species of *Psithyrus* and the degree of difference from *Bombus*, and (2) the probable way in which parasites are produced from industrious species in the Aculeates as a whole.

(1) In the earlier discussion of the generic characters of *Psithyrus*, all the structures that could possibly be due to known peculiarities in the life-history were indicated. Every possible concession was made to the adaptational view of the generic characters, yet there were still eight of no known significance which were common to all the species of *Psithyrus* and found in no species of *Bombus*. Probably some of the characters which were " explained " as possible adaptations or as indirect effects of the thickening of the integument, should really be added to the other eight. It is also of importance that the supposed indirect effects of increased chitinisation should be identical in all the species. It is difficult to see why, for instance, one effect on all the species should be to make the hairs on the sting-palp more numerous (27), unless the species were so closely allied that they would be similarly affected by the increase of chitinisation. Gaschott, as already stated, believes that the genus must in fact be monophyletic, since the species resemble one another more than any one species of parasite does its host. There is, however, an argument for the other side that may be drawn from structure. The species of *Psithyrus* are undoubtedly more distinct from one another than are the members of any subgenus of *Bombus* ; almost every one of the parasites might be put in a subgenus of its own. Thus, although the parasites do not structurally resemble their hosts, there is at least some evidence that the genus is polyphyletic. I think this problem can never be solved by these morphological methods, because no one knows to what extent structural convergence may be carried as a result of parasitic life.

(2) Considering the problem as part of the more general one, the origin of parasites amongst Aculeates, there is much additional evidence in favour of the polyphyletic origin.

There appear to be two ways in which a wasp or a bee can become parasitic, when circumstances drive it to adopt that mode of life. It may either victimise some unallied species which happens to prey on the same type of insect or use the same nest material, or it may attack one of its close allies, whose habits would usually be similar to its own. There is little evidence that the former is common or has often led to permanent parasitism, though the Raus (1918) have proved such a relation exists between the American *Stizus unicinctus*, Say, and *Prionony x thomae*, F. It is probable that close allies would much the most often have the right prey or nest material available at the right time of the year. It is found in practice that each family of bees has its own group of parasitic species. Under the older classifications all the parasitic bees were grouped together in one subfamily because they lacked the pollen-collecting apparatus, and because they agreed in having a thick integument and bright colours. It has long been known that this subfamily was polyphyletic, and I believe that many even of the genera are similarly heterogeneous. The genus *Nysson*,* parasitic on the sandwasps of the genus *Gorytes*, is a particularly interesting case. The host genus can be divided on structural considerations into four subgenera, and each species of the parasitic genus, as far as is known, restricts itself to a few allied host-species falling into one only of the subgenera. Now the species of *Nysson*, though associated in a fairly well characterised genus, differ from one another structurally in the same way as do their host

* There is no adequate study of the genera *Nysson* and *Gorytes* and of their relations, but my remarks are certainly true of the British species.

species. Thus it would be possible, using the same characters, to separate both the host and the parasitic genus into subgenera, each related as host and parasite. It is therefore quite evident that the genus *Nysson* is polyphyletic and that the various species have arisen independently from different subgenera of *Gorytes*. The generic characters of *Nysson* are the result of convergence. All genera, of course, are to some extent the result of convergence, since it is unlikely that they could ever be traced back to a single pair of individuals, but in the parasitic Aculeates this convergence can be detected more easily than usual.

We may now return to the recorded cases of incipient parasitism in the genus *Bombus*. The best-known case is the occasional usurpation of the nests of *B. lucorum*, L., by the females of *B. terrestris*, L., described by Sladen (1912). The behaviour of the invader in no way differs from that of a *Psithyrus* (the host-queen being killed), except that the parasitism is not permanent. Bischoff (1923) and Scholz (quoted by Gaschott, 1922) also record the occurrence of mixed nests in the case of certain species. There is no indication in these records of the real relations between the two queens. In some of the nests they may have only been temporary lodgers. Plath records (1924) that the queen of certain American species will often invade a nest of her own species, killing the rightful owner and usurping her place.

The first generalisation that can be drawn from the records of this type of behaviour, is that a robber *Bombus* queen nearly always attacks her own or a closely allied species. It may be suggested that this may be due to a preference for a not too unfamiliar nest-odour.

This behaviour would lead to the polyphyletic origin of parasites, each parasite species being restricted to one or to a few related host-species. There is, however, some evidence in other families of bees suggesting that when once the parasitic habit becomes deeply rooted, the parasite may begin to attack bees of allied genera or even of different families, as has probably happened in the case of *Nomada*.

The records of incipient parasitism in *Bombus* are not sufficiently numerous to show whether species of a southern type are most frequently the robbers. Certainly *B. terrestris*, L., is a more southern form than *B. lucorum*, L. On the other hand, in the case of *B. distinguendus*, Mor., whose occasional parasitism on *B. subterraneus*, L., is recorded by Lindhard (quoted by Krüger, 1920, p. 367; cf. also Fleming, 1926), the parasite is definitely of a northern type. The same appears to be true of *Vespa austriaca*, Pz., the social wasp parasitic on *V. rufa*, L. Mr. A. E. Bradley tells me that the queens of *B. distinguendus*, Mor., come out of hibernation very late, so that we may suppose they find the nests of their hosts already formed; the way to parasitism would thus be open. We cannot in this case explain why *distinguendus* should emerge so late in the season. *V. austriaca*, Pz., also appears much later than the industrious species, but, since we are here dealing with a fully developed parasite, the altered habit may be the effect of the new mode of life.

To sum up then: the invasion of nests, in some cases leading to usurpation, is a widespread habit in humblebees. The nests invaded are usually those of species closely allied to the invader. Such invasion is probably, as a general rule, the consequence of the invader appearing late in the spring and finding the host-nest already built. In most cases there is no reason why the invading species should consistently appear later in the spring than its host, so that many examples of incipient parasitism probably never develop further. It may be imagined, however, that a species on the northern edge of its range

might always appear later than those better adapted to the local climate, and the conditions for the further development of parasitism might thus arise. This theory is independent of the suggested similarity between southern and parasitic types of bees.

These facts suggest that parasitic genera arise polyphyletically from the different species of the host-genus. The case of *Nysson* shows how species which have arisen independently can assume a common facies (actually given a generic name) as the result of convergence owing to the parasitic mode of life. It is probable, though by no means proved, that *Psithyrus* is also polyphyletic.

Plath (1922) has gone so far as to suggest that the colour-resemblances between the species of *Psithyrus* and their hosts are the result of the genetic relationship between them. This theory is not supported by a study of the European species. *Ps. barbutellus*, K., in the female (and even more in the male) certainly resembles a dark form of its host, *B. hortorum*, L. *Ps. rupestris*, F., in both sexes, but especially in the female with her nearly black wings, is much darker than average specimens of the host, *B. lapidarius*. L. None of the other British species of *Psithyrus* resembles its host at all closely, and each can easily be distinguished from its host, even when flying. There are much more striking cases of resemblance between species belonging to different subgenera of *Bombus*, and most of the species of that genus in different parts of their range appear, either in a variety or in a closely allied species, in colour-patterns resembling other quite distinct species. The resemblance between *Psithyrus* species and their hosts is scarcely greater than might be expected on the laws of chance in such polymorphic genera. Nevertheless, it is, perhaps, significant that *Ps. sylvestris*, Lep., and *Ps. rupestris*, F., the only species in which red appears in the tail, parasitise subgenera of *Bombus* in which also red often appears. Similarly the hosts of *Ps. campestris*, Pz., a species in which white is always absent from the tail, also lack the white. The other species of *Psithyrus* normally have white tails and so have their hosts. Thus, although the details of the colour-pattern of host and parasite do not resemble one another in a significant way, yet these patterns appear to be governed in part by the same fundamental laws. This is further evidence in favour of the polyphyletic origin of *Psithyrus*.

XIII. A Discussion of the Specific Characters of Humblebees.

It will be seen that in the keys to the species great use is made of characters drawn from the male genitalia. What is the significance of these characters? Many authors have compared the female insect to a lock which only one key, one special type of male genitalia, can fit. There is in reality practically no evidence for this view. In many groups there are no corresponding differences in the genitalia of the female; in humblebees where the sting differs to some extent amongst the species, there is no evidence that these differences are in any way connected with copulation. This could only be settled by the study of a pair actually mating. The subject has already been discussed very efficiently by Boulangé (1924); he found that the stipes, volsella and squama, that is the most complex part of the genitalia, do not enter the abdomen of the female at all, but grip the sides of the sixth sternite. These structures, then, though very different in the various species, grip a part of the female which is identical (or nearly) in all species. Probably species with distinct genitalia rarely attempt to copulate with one another; even species with nearly identical genitalia, whose differences could scarcely interfere with crossing, such as those

of the subgenus *Pratobombus*, Vogt, probably do not attempt to interbreed; but the barrier is one of instinct not of structure.

Boulangé goes further to say that genitalia have no greater weight in deciding the limits of species than any other criteria. With this opinion I must disagree; although the genitalia of closely allied species may be identical, yet in insects as a whole they stand out as being more important than any other single character, in spite of the fact that their intensive study has been started only comparatively recently. The specificity of the genitalia is specially distinguished by differences in kind rather than degree, and by the lack of variation of such magnitude as to make allied forms overlap.

It is impossible to say at present why the genitalia should be modified so early in the course of specific differentiation, though a suggestion may be thrown out as to how the small differences in other characters may become exaggerated in the genitalia. Both in the male genitalia and in his modified seventh and eighth sternites, it is the least chitinised parts that vary most in shape. This is very noticeable in the squama of *Psithyrus* and in the exact outline of the eighth sternite of all humblebees. If the amount of chitin available can be regarded as limited, though somewhat variable, in quantity, then, when not enough chitin was produced, areas normally forming a part of the structure in question would merge indistinguishably with the arthrodial membranes. Conversely, part of the membrane could become chitinised and make a considerable difference in the shape of a hard structure but a scarcely noticeable one in the amount of membrane. Where a structure is strongly chitinised, small variations in the amount of chitin would not affect its shape, since they would still leave it with a very different texture from the surrounding parts. Such variations in the shape of structure can be seen very clearly in the seventh sternite of *Psithyrus*. This sclerite is essentially tridentate at the apex, with a membrane joining all the projections together and extending considerably beyond them. When the sternite is relatively weakly chitinised, as in *Ps. campestris*, Pz., the tridentate structure is obvious, while in *Ps. vestalis*, Fourcr., the whole sternite, including the membrane, is more strongly chitinised and in some specimens the tridentate structure is entirely obscured. Probably a somewhat similar process accounts for the specific shapes of the lamella of the squama in the subgenus *Agrobombus*, Vogt, though no doubt in this and in most cases many other factors, at present unknown, are important.

Lastly the connection between the structural and habitudinal species-differences must be considered. The length of the tongue (more or less correlated with the length of the malar space) is in some cases evidently correlated with the type of flower most frequently visited, *e.g.* in the case of *B. hortorum*, L., that visits mainly flowers with a long corolla. Marked differences in tongue length, however, usually separate subgenera rather than closely allied forms. Closely allied species and, indeed, most subgenera differ in characters having no apparent direct connection with the mode of life. No doubt in many cases there is an indirect connection through a physiological adaptation, but this remains to be demonstrated.

XIV. The Application of the Phylogenetic Method to the Species of a Genus.

Various authors, including Krüger (1920), have constructed family trees which they imagine represent the evolution of the species within the genus. Such pedigrees are, in my opinion, largely illusory and based on unverifiable

premises. Probably all the species-groups to which Latin names have been given in the key are monophyletic, but the relations of these groups to one another and of the species within them cannot really be determined. There is usually a permutation of characters, connecting species in various directions, making the construction of a pedigree impossible. It must be emphasised that it is impossible to assume that the more complex types of structure are necessarily those which have evolved furthest. This can only be determined if the stock whence the genus arose is known. It is probable that *Bombus* must be derived from forms resembling *Euglossa*, but I am not aware that an adequate comparison of the structure of these two genera has ever been made.

Even if some idea of the evolution of the various subgenera were obtained, it is certain that the species within each group would nearly always show relationships in several directions. A convincing phylogeny can only be constructed when most of the links in the complete genetic chain have been lost.

XV. Summary and Conclusions.

1. The British species of *Bombus* and *Psithyrus* have been compared and their specific characters, including many not previously noted, have been indicated. The subgenera into which the species have been divided have been further defined; subg. *Terrestribombus*, Vogt, has been regarded as synonymous with *Bombus*, Latr. s.s. and *Fervidobombus*, Skor., with *Pomobombus*, Vogt.

2. The genera *Bombus* and *Psithyrus* have been compared and are shown to differ in numerous morphological characters of which many appear to be connected with the parasitic mode of life of the latter genus, while others appear to have no direct significance.

3. The genus *Psithyrus* must undoubtedly be derived from *Bombus*. The morphological evidence on the whole indicates a monophyletic origin. A study of the habits of parasitic Aculeata in general seems, however, to show that each group of *Psithyrus* has arisen from the ancestor of its host species. Though it is very difficult to come to a definte conclusion, a polyphyletic origin seems on the whole the more probable.

4. It is suggested that parasitic Aculeata as a whole tend to resemble southern races of industrious species in their colour and pubescence. This may indicate that species tend to become parasitic at the northern edge of their range, the adverse conditions there encountered tending to make permanent the temporary and local parasitism which is not uncommon within many species.

5. The specific characters of humble-bees do not appear to have any direct connection with the life-histories of the species.

6. It is not possible, as has been previously attempted, to draw up detailed phylogenies of the species of a genus, though it may be possible to define groups (such as the subgenera of *Bombus*) which are probably monophyletic.

XVI. Bibliography.

(This includes papers quoted in the text; it is not, of course, a complete one of the genus.)

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Explanation of the Plates.

Plate XXII.

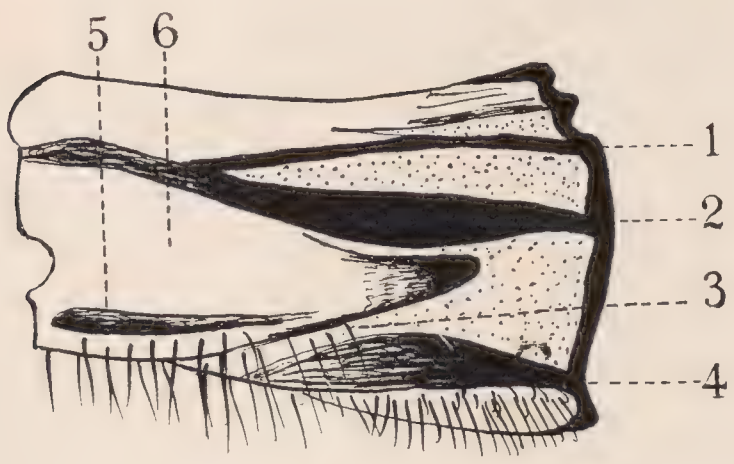
Fig. 1. Right mandible of *Bombus sylvarum*, L., female. (Keels shown in black.) (1) Main keel. (2) Second keel. (3) Sulcus obliquus. (4) Incisura lateralis. (5) Basal keel. (6) Basal area.

2. (*a*) Basal part of the maxilla of *B. lapidarius*, L., showing the palp. (*b*) The maxillary palp of *B. ruderarius*, Muell. (*derhamellus*, K.).
3. The prothorax of *Bombus* female from beneath. (1) Neck. (2) Right propleuron. (3) Prosternum. (4) Right coxa. (5) Right trochanter.
4. Prothorax of *Bombus* female from beneath, the coxae removed. (1) Right propleuron. The rest of the figure is made up of the various processes of the prosternum; those marked (*a*) touch one another in *Bombus*.
5. Posterior view of the prosternum of *Bombus* female, showing processes (*a*) touching one another.
6. Posterior view of the prosternum of *Psithyrus* female, showing the processes (*a*) not touching one another.
7. Left mid metatarsus (*a*) of *Bombus terrestris*, L., (*b*) of *B. solstitialis*, Pz. (*helferanus*, Seidl.).
8. Apex of the claw joint of *Bombus* from beneath. (1) Fourth tarsal bristle.
9. Attachments of the arthrodial membranes between the segments. Explanation in the text, p. 236.

Plate XXIII.

Fig. 10. The first two abdominal sternites of *B. terrestris*, L., female seen from beneath. (Dots represent long hairs; cross-hatching, short decumbent pubescence.) (1) Basal lamella of the first sternite. (2) Basal depression of the first sternite. (3) Lateral bare space of the first sternite. (4) Lateral margin of the first sternite. (5) Lateral patch of decumbent pubescence of the second sternite.

11. The same in *Psithyrus vestalis*, Fourcr., female. (1–5) The same. (6) Lateral decumbent pubescence of first sternite. (7) The raised subapical margin of first sternite. (8) The raised line across the second sternite.
12. The sting of *Bombus* in its natural position seen from the left. (Cross-hatching represents membrane.) (1) Sting-sheath. (2) Outer projection of the sting-sheath. (3) Inner projection of the sting-sheath. (4) Lancet. (5) The bulb of the sting. (6) The furcula. (7) The domed membrane. (8) The inner sting-plate. (9) The lateral projection of the inner sting-plate. (10) The connecting piece. (11) The outer sting-plate. (12) The transverse line on the outer sting-plate. (13) The sting-palp. (14) The anus.
13. The spiracular plate of *Bombus*. (1) Area attached by membrane to the 6th sternite and tergite. (2) Area attached by membrane to the transverse line on the outer sting-plate
14. The outer sting-plate of *Psithyrus*. (1) The appendix.
15. Dorsal view of the male genitalia of *B. terrestris*, L. (1) Cardo. (2) Stipes. (3) Parapenial process of stipes. (4) Volsella. (5) Squama. (6) Spatha. (7) Sagitta.
16. Dorsal view of the penis of *B. terrestris*, L. (1) Spatha, produced into a point at (2). (3) Sagitta. (4) Junction of the spatha and sagitta.



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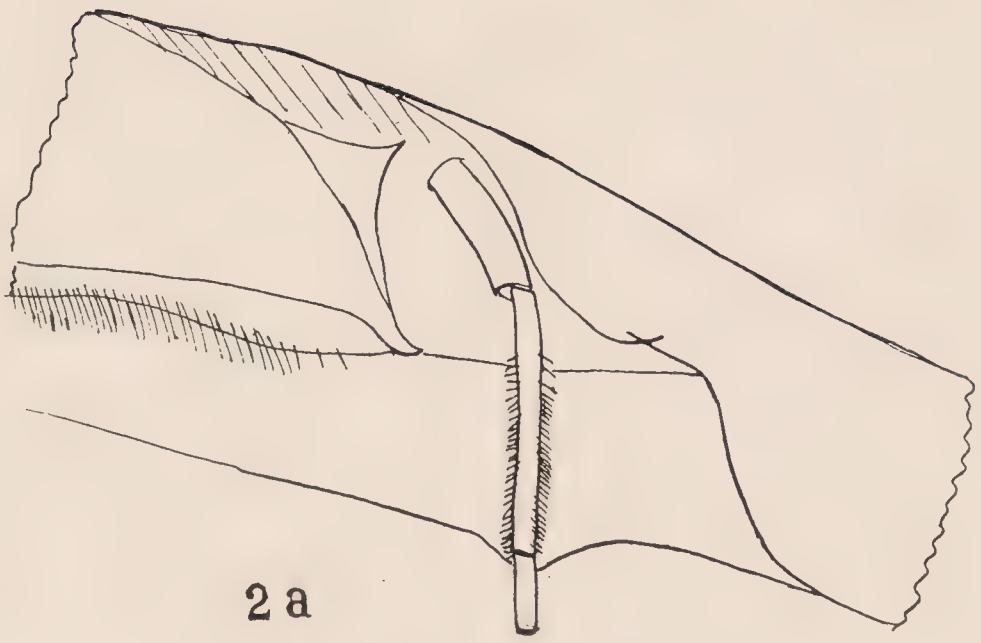

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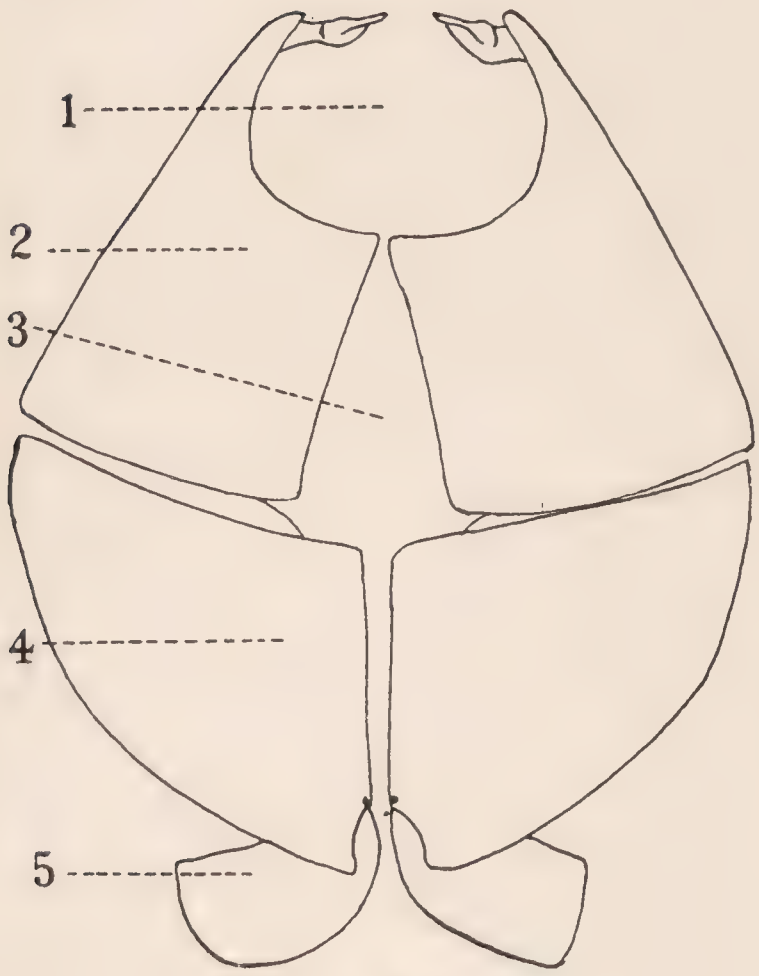

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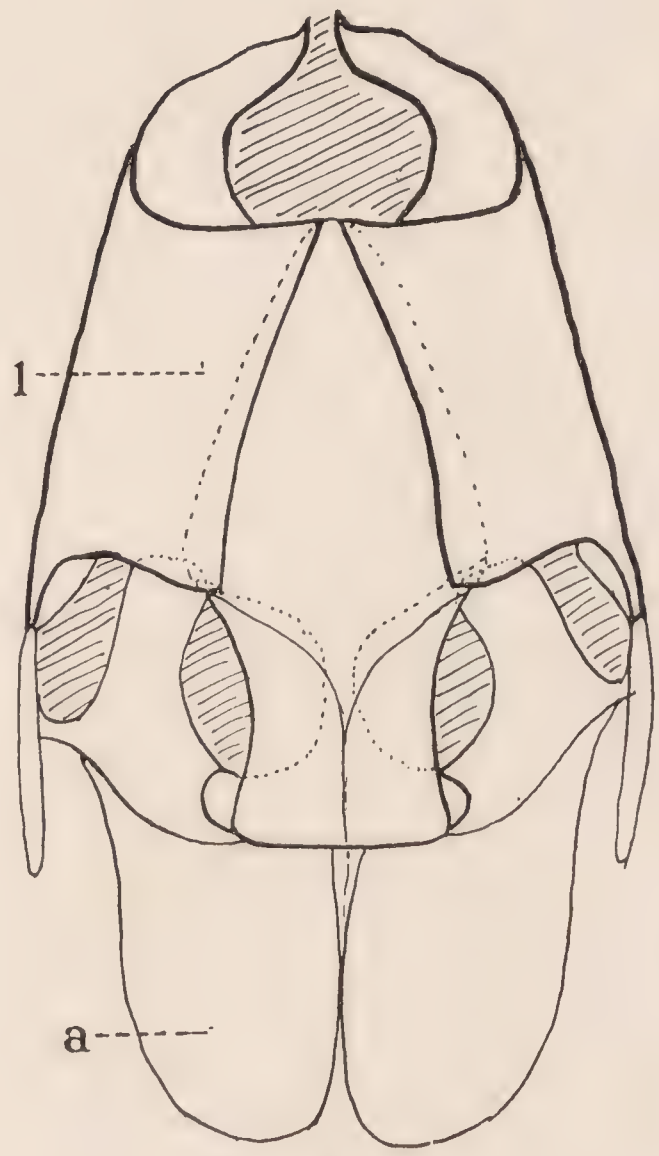

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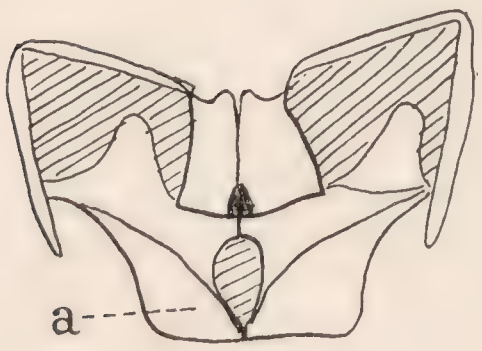

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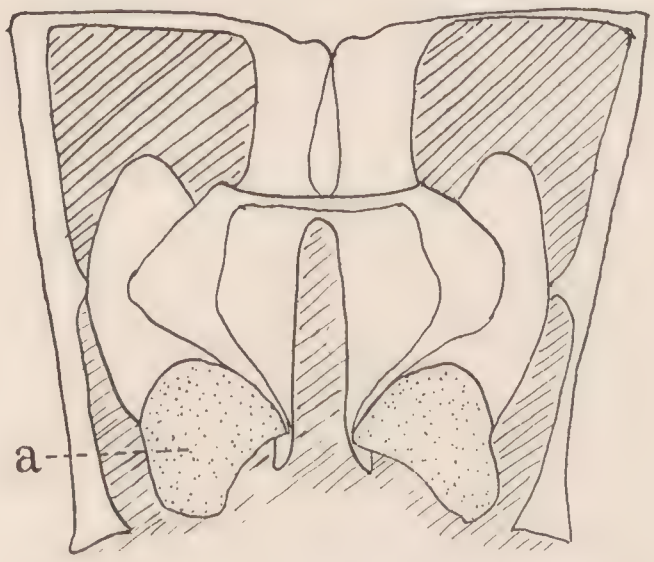

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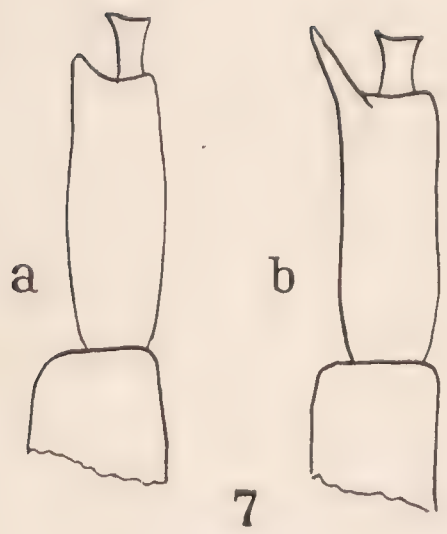

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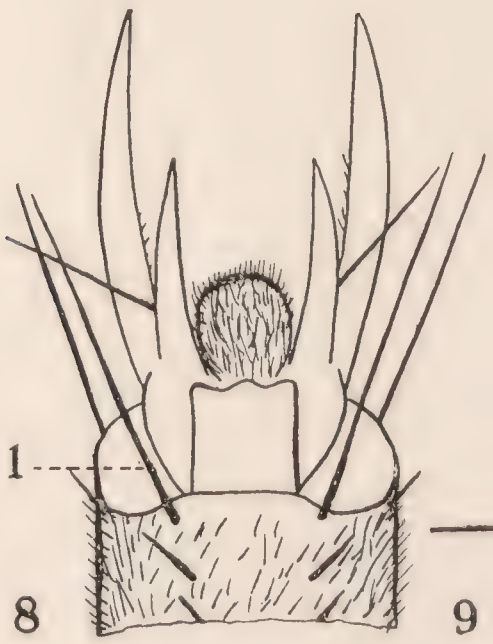

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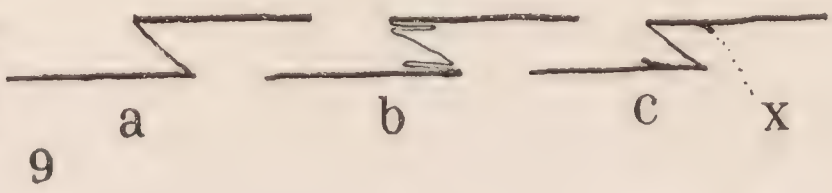

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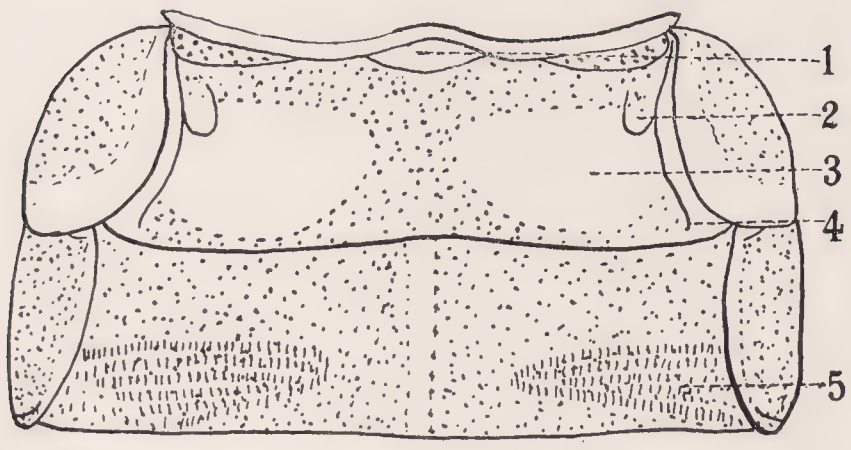

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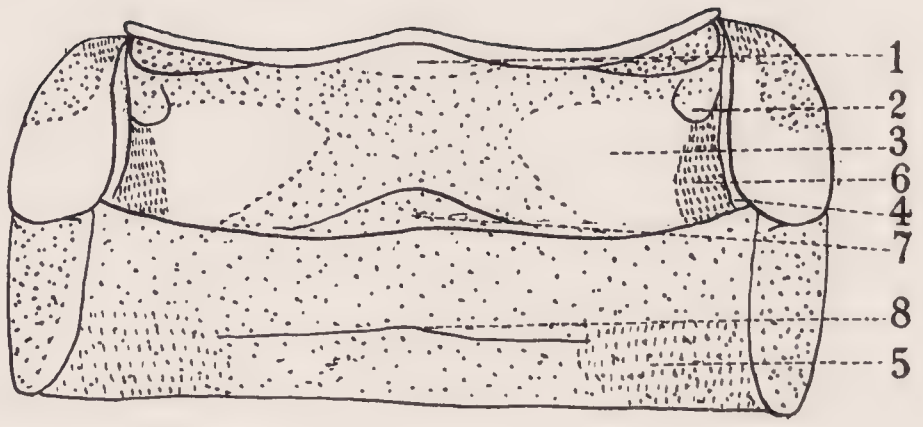

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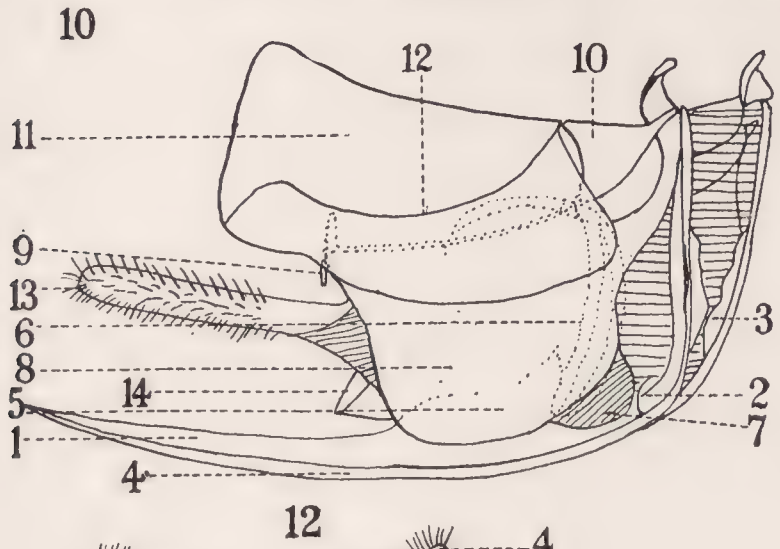

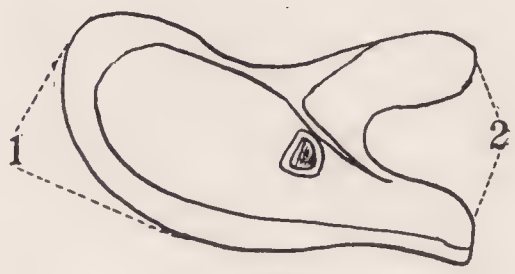

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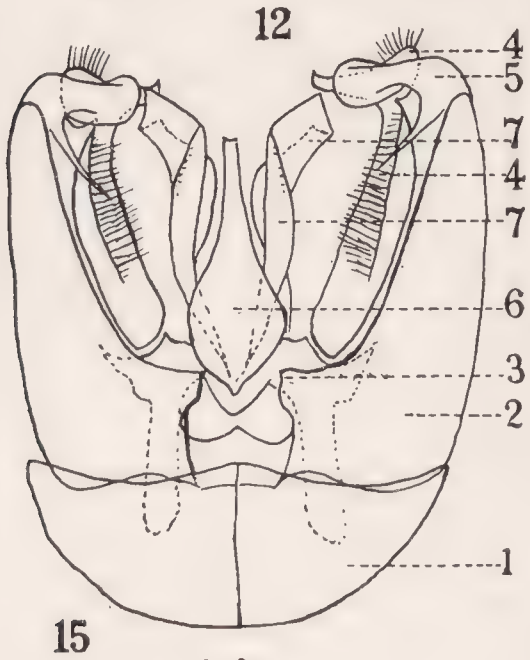

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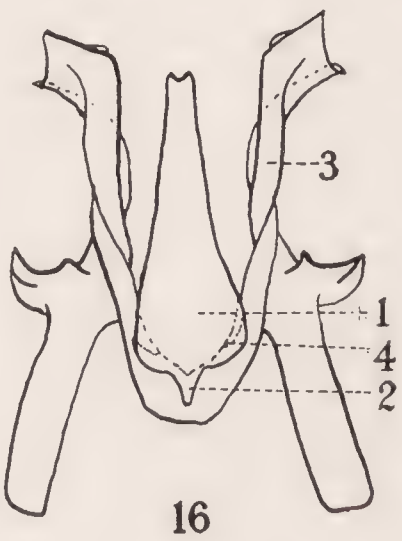

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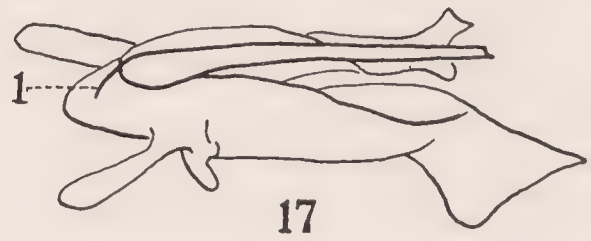

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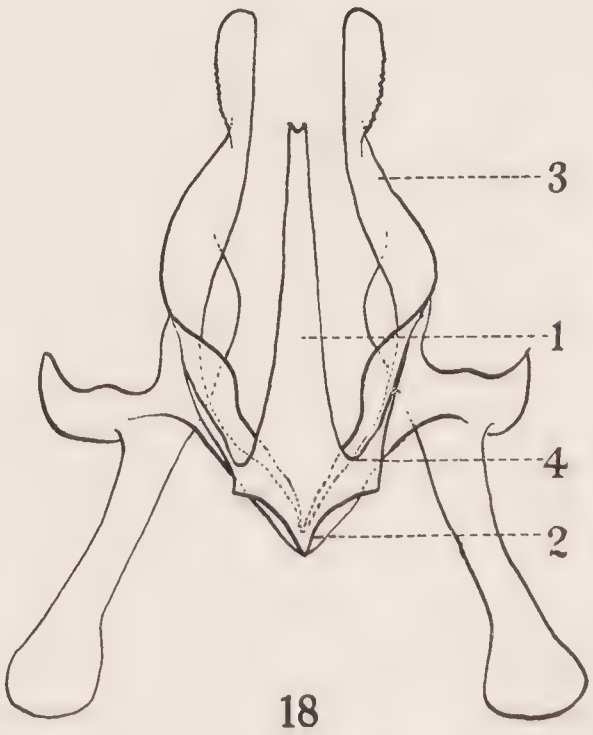

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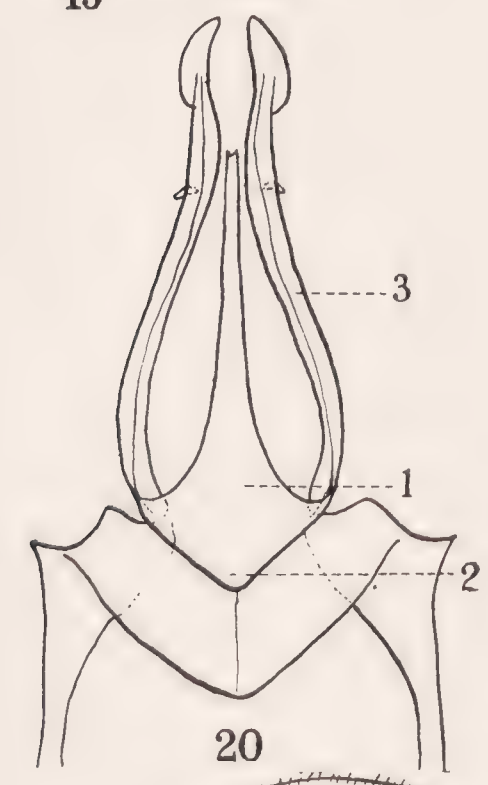

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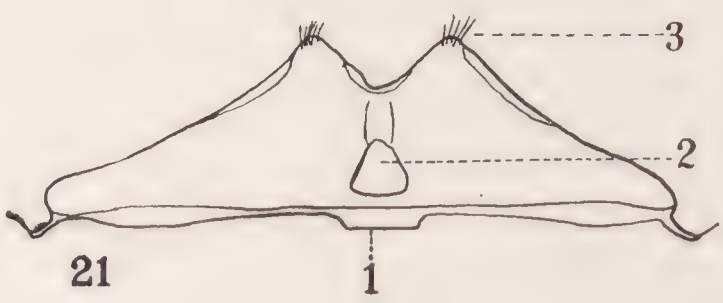

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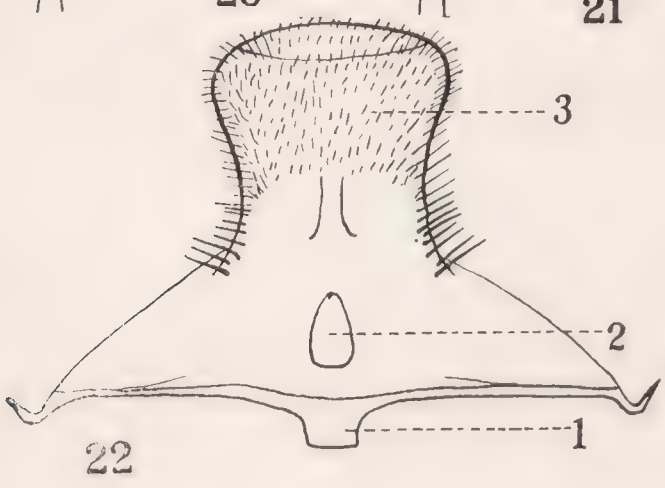

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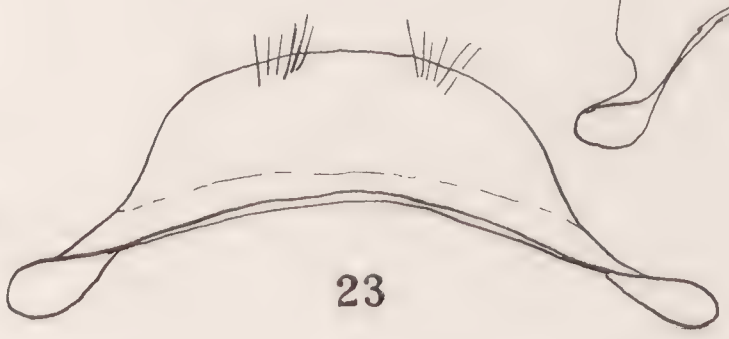

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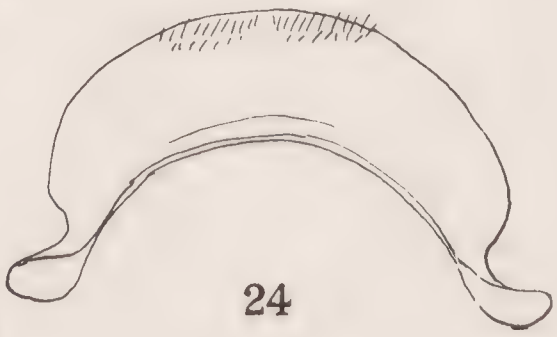

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Fig. 17. The same from the left side. (1) Keel on the fused bases of the sagittae.
18. Dorsal view of the penis of *B. agrorum*, F. (1) Spatha, produced into a sharp point at (2). (3) Sagitta. (4) The junction of the spatha and sagitta.
19. The same from the left side. (1) Keel on the fused bases of the sagittae, projecting beyond the latter.
20. Dorsal view of the penis of *Psithyrus rupestris*, F. (1) Spatha, rounded at (2). (3) Sagitta.
21. The eighth sternite of *B. terrestris*, L., male. (1) Basal projection. (2) Perforation. (3) Apical tuft.
22. Eighth sternite of *B. agrorum*, F., male. (1–3) The same.
23. Seventh sternite of *B. terrestris*, L., male, showing the apical hair-tufts.
24. Seventh sternite of *B. agrorum*, F., male, showing the continuous apical hair-tuft.

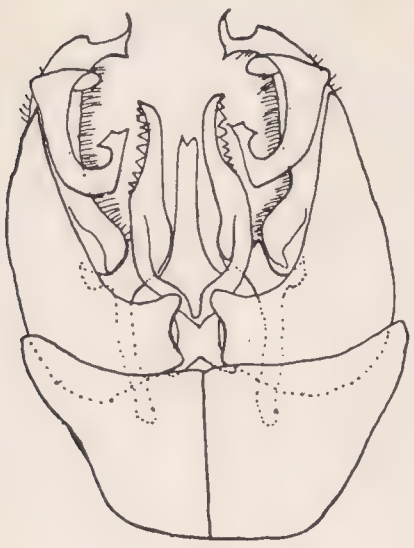
Plate XXIV.

Figs. 25–39. Genitalia of male *Bombus*, dorsal view.
Fig. 25. *B. hortorum*, L.
26. *B. elegans*, Seidl.
27. *B. subterraneus*, L. (*latreillellus*, K.). 27 (*a*). Preapical process of the sagitta. 27 (*b*). Preapical process of the sagitta in *B. distinguendus*, Mor.
28. *B. ruderarius*, Muell. (*derhamellus*, K.).
29. *B. sylvarum*. L.
30. *B. agrorum*, F.
31. *B. solstitialis*, Pz. (*helferanus*, Seidl.).
32. *B. muscorum*, F.
33. *B. soroënsis*, F.
34. *B. terrestris*, L. (genitalia, fig. 15). (1) Apex of the volsella seen from beneath. (2) The same in *B. lucorum*, L.
35. *B. lapidarius*, L.
36. *B. cullumanus*, K. (Sussex).
37. *B. pratorum*, L.
38. *B. jonellus*, K. Base of stipes showing (at (*a*)) the more produced paraphenial process.
39. *B. lapponicus*, F. (*a*) Stipes produced inwards at the apex and volsella strongly emarginate at the apex. (*b*) The spatha and left sagitta from the side, showing the tooth beneath the latter at (1).
Figs. 40–45. Male genitalia of *Psithyrus* in dorsal view.
40. *Ps. sylvestris*, Lep.
41. *Ps. vestalis*, Fourcr.
42. *Ps. bohemicus*, Seidl. (*distinctus*, Pérez). Apex of stipes showing the shape of the squama.
43. *Ps. barbutellus*, K.
44. *Ps. rupestris*, F.
45. *Ps. campestris*, Pz.

Plate XXV.

Figs. 46–58. Stings of female *Bombi*; view of the inner projections of the sting-sheath, the ventral side being directed towards the top of the page. The dots represent degrees of chitinisation.
Fig. 46. *B. hortorum*, L.
47. *B. hortorum*, L. Sting from the side. (1) Sting-sheath. (2) Inner sting-plate. (3) Domed membrane. (4) Isolated chitinised thickening in membrane of the inner sting-plate.

FIG. 48. *B. elegans*, Seidl.
49. *B. subterraneus*, L. (*latreillellus*, K.).
50. *B. ruderarius*, Muell. (*derhamellus*, K.). (*a*) Inner projections from the sting-sheath. (*b*) Sting from the side. (1) Sting-sheath. (2) Outer projection of the sting-sheath, which is broad ventrally. (3) Domed membrane. (4) Inner sting-plate.
51. *B. agrorum*, F.
52. *B. solstitialis*, Pz. (*helferanus*, Seidl.).
53. *B. muscorum*, F.
54. *B. soroënsis*, F.
55. *B. terrestris*, L.
56. *B. lapidarius*, L.
57. *B. cullumanus*, K.
58. *B. pratorum*, L.
59. *B. pratorum*, L. Stigmatic plate.
60. *B. terrestris*, L., female, inner sting-plate showing the length-measurement taken.
61. *B. terrestris*, L., male, stipes showing the length-measurement taken.



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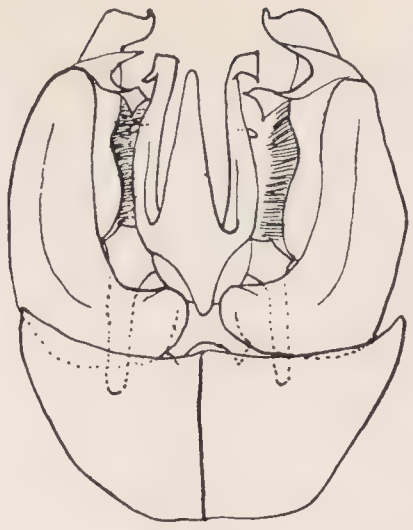

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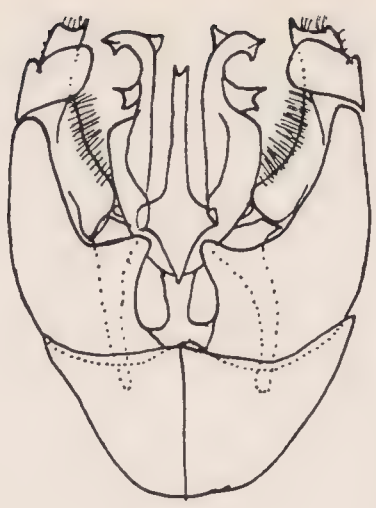

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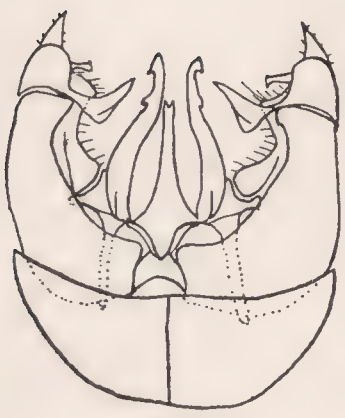

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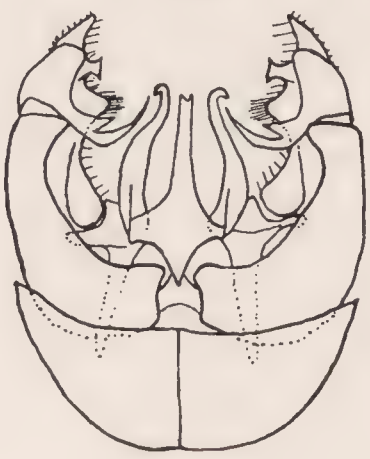

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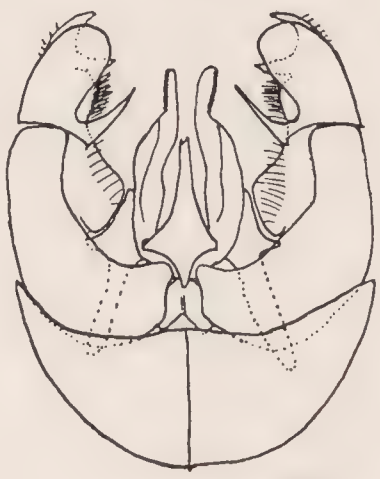

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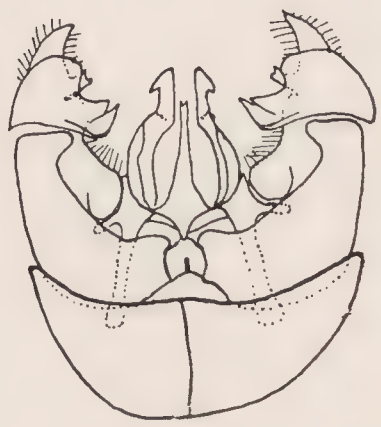

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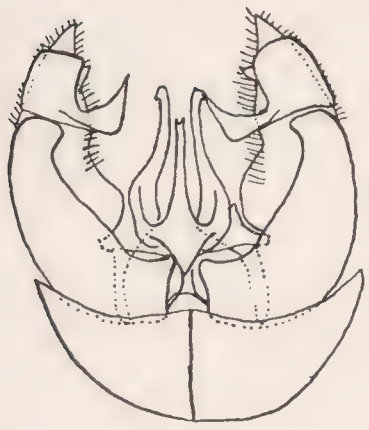

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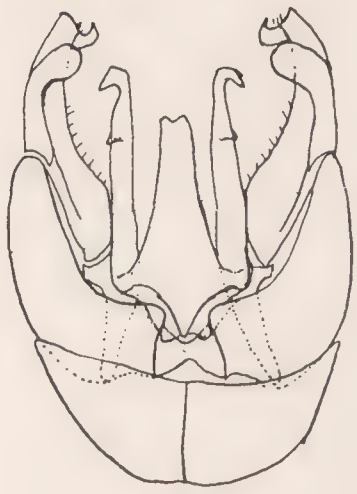

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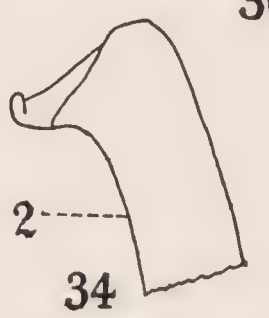

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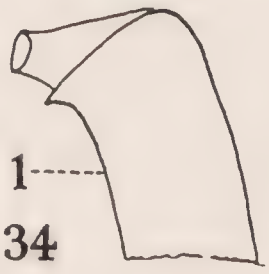

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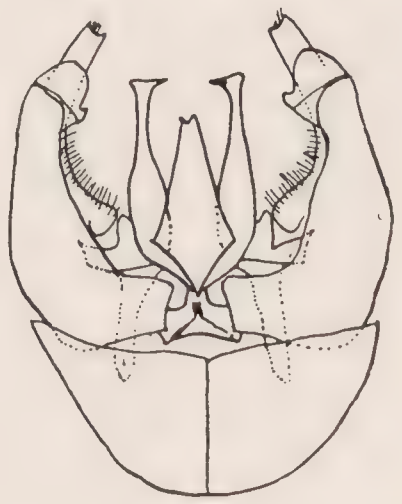

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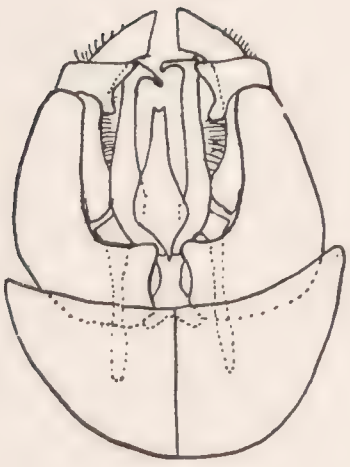

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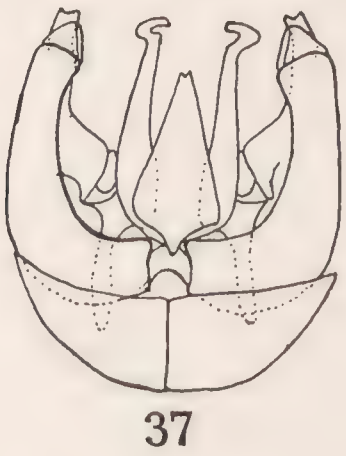

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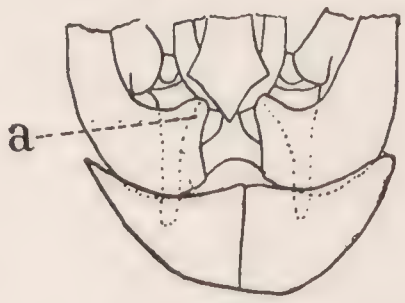

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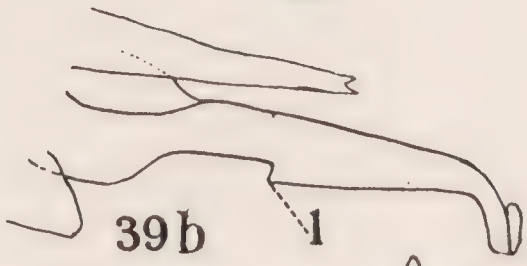

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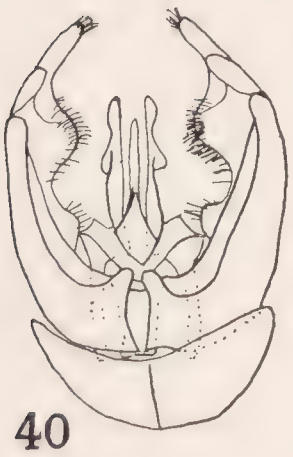

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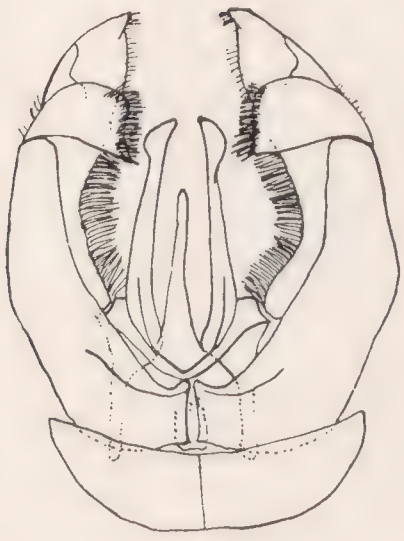

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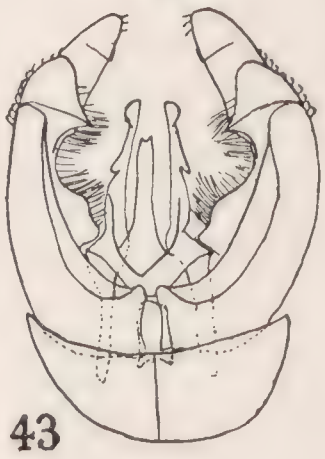

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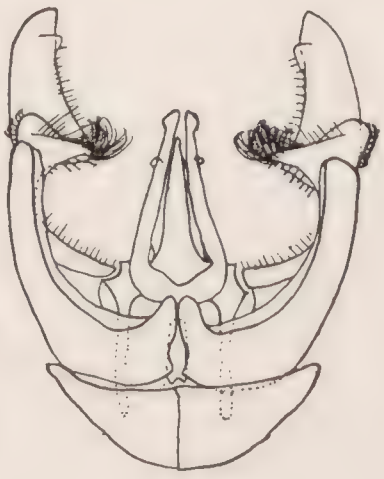

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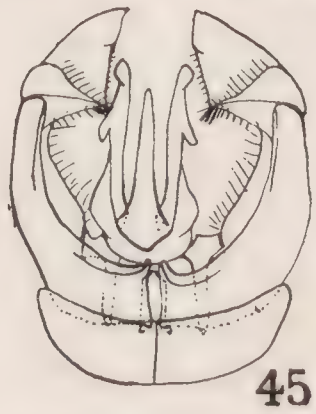

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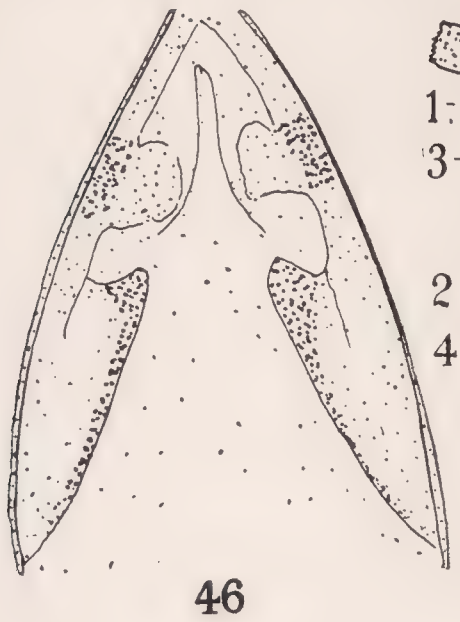
THE BRITISH HUMBLEBEES.



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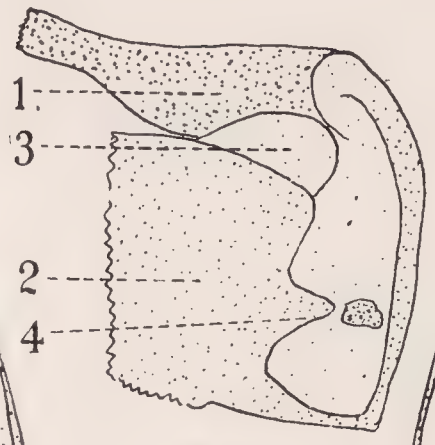

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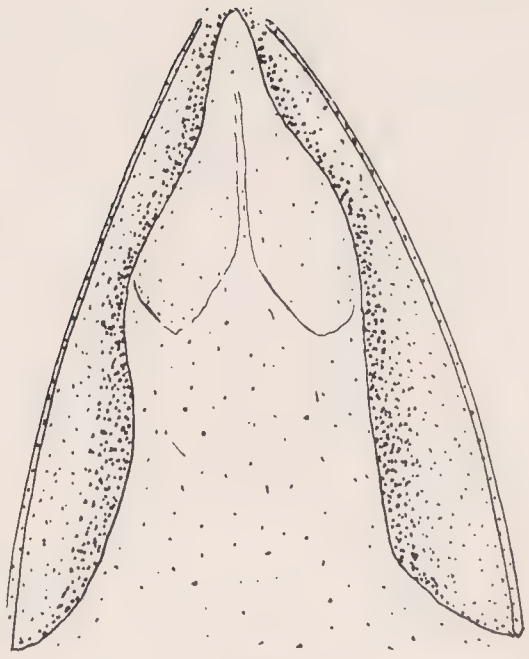

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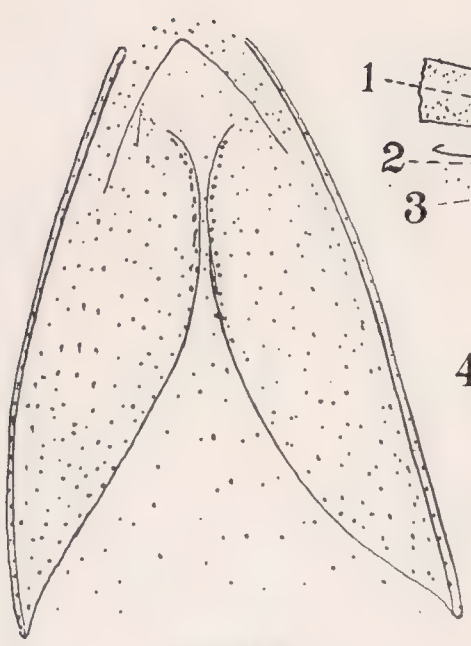

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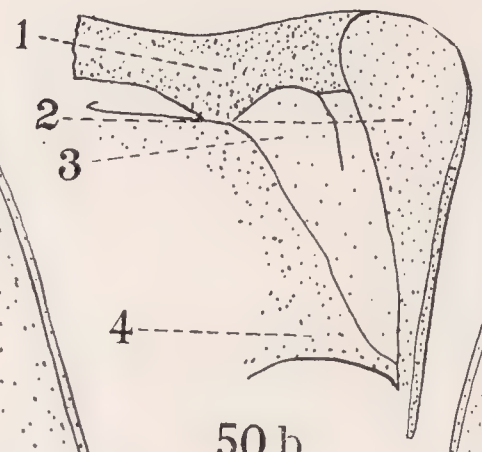

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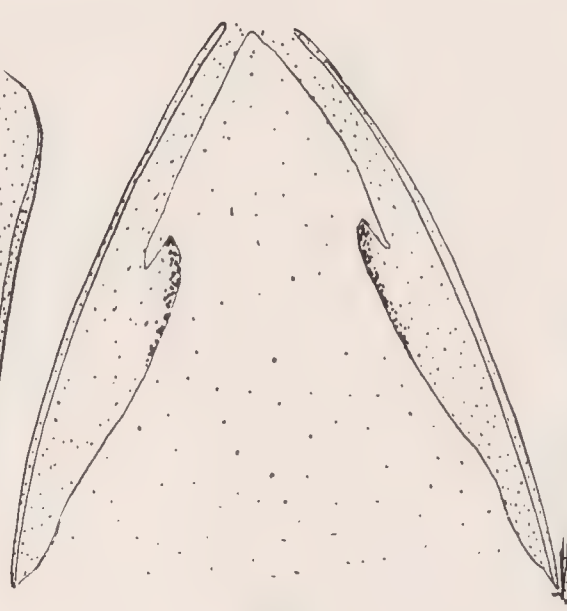

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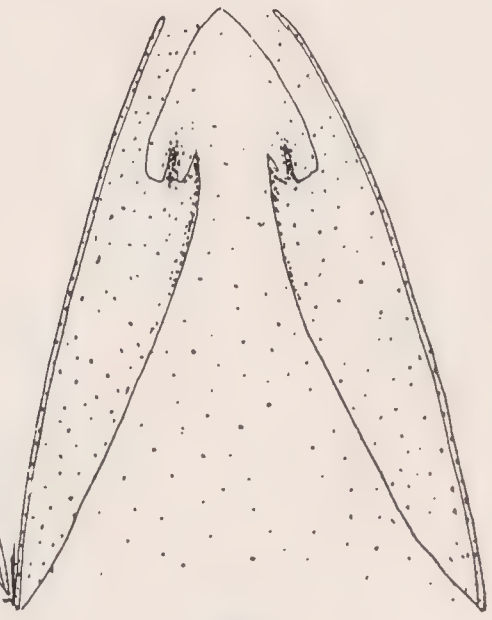

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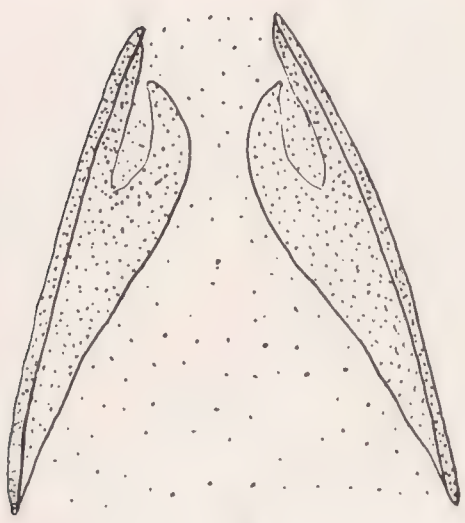

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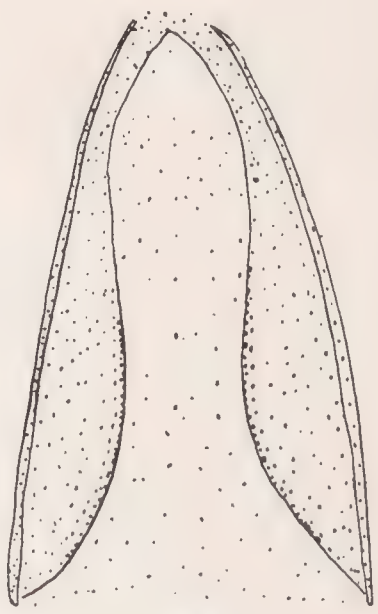

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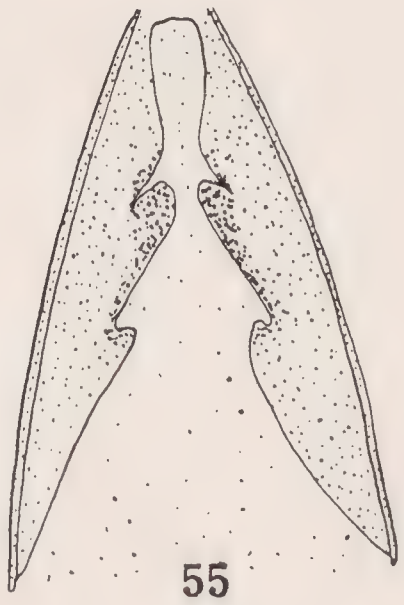

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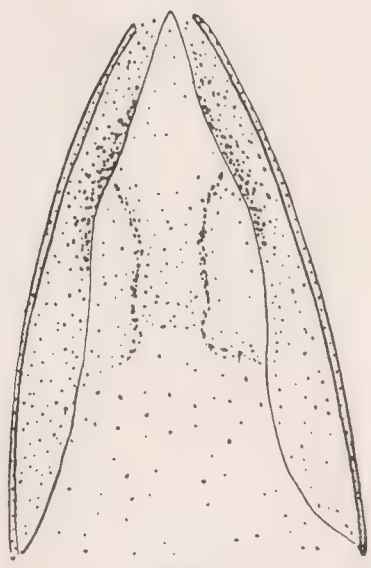

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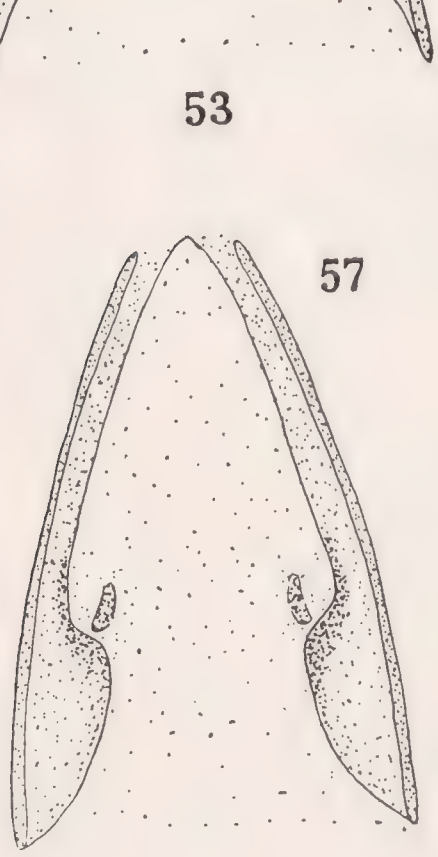

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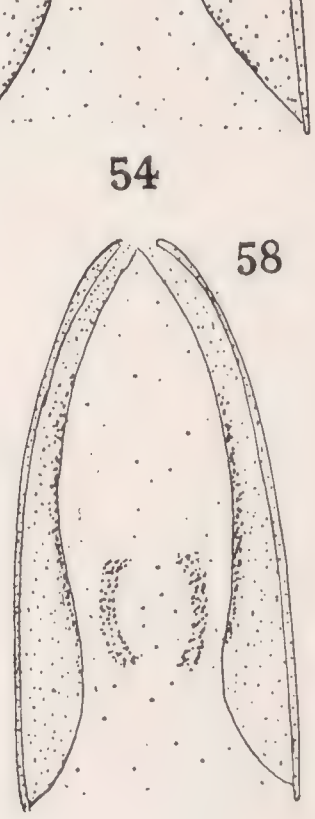

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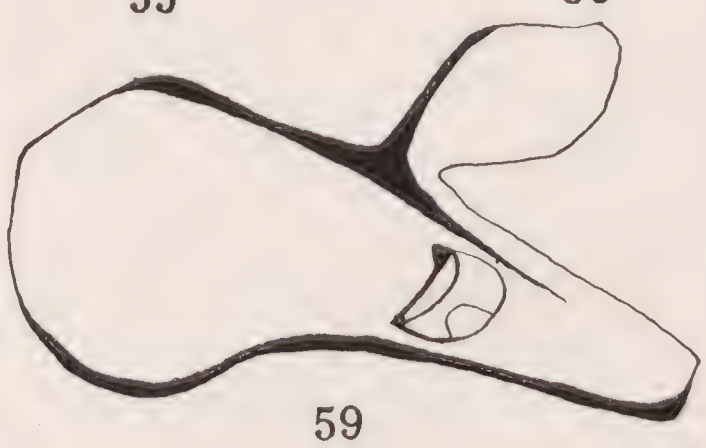

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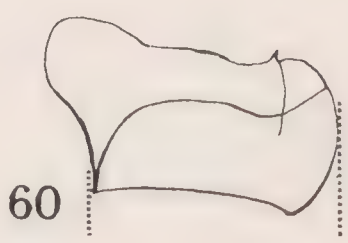

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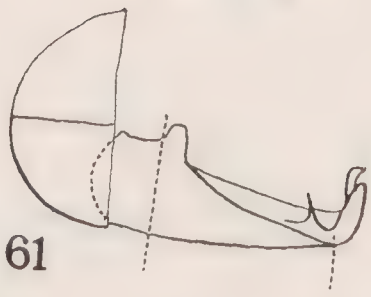

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ON SOME OBJECTIONS TO MIMICRY THEORY; STATISTICAL AND GENETIC

By R. A. Fisher, Sc.D.
(Rothamsted Experiment Station, Fellow of Gonville and Caius College.)
(Communicated by Prof. E. B. Poulton, F.R.S.)

[Read October 5th, 1927.]

I. Introductory.

The great statistical interest of all applications of selection theory, of which mimicry is certainly one of the most extensive and detailed, makes the validity of the latter a matter of importance even beyond the limits of the biological sciences. Moreover, it appears to be probable that disputed points which have arisen in discussions of mimicry, should, in so far as they are of a purely statistical nature, be capable now of a definite and final decision. The importance of inheritance in selection theory has led to a study of the statistical effects of Mendelism, with the result that the genetical arguments are in nearly the same position as the purely statistical. It is now becoming increasingly widely understood that the bearing of genetical discoveries, and in particular of the Mendelian scheme of inheritance, upon evolutionary theory is quite other than that which the pioneers of Mendelism originally took it to be. These were already, at the time of the rediscovery of Mendel's work, in the full current of that movement of evolutionary thought, which in the nineties of the last century, had set in in favour of discontinuous origin for specific forms. It was natural enough, therefore, that the discontinuous elements in Mendelism should, without sufficiently critical scrutiny, have been interpreted as affording decisive evidence in favour of this view. No attempt will here be made to give an extended account of the general bearing of Mendelism upon evolutionary theory; it should, however, be borne in mind that the reinterpretation of the significance of Mendelism in cases of mimicry is but part of a more general recovery of genetical opinion from positions adopted at a somewhat immature stage of the development of that science.

It seems to the author imperative, in undertaking such a task, the value of which depends solely upon its logical cogency, to insist upon the fact that, in criticising biological conclusions, the criticism is solely aimed at their supposed relation to the observations upon which they are based, and is in no way opposed to, or confirmatory of, these observations. Mathematical symbolism will be avoided; nevertheless the work will be mathematical in the sense that for the sake of certainty and precision upon the points discussed, innumerable side issues, some possibly of importance, will be totally disregarded, and the biological facts utilised will be reduced to a mere abstract of their real complexity.

II. Supposed Statistical Limitations of Müllerian Mimicry.

Certain *a priori* statistical limitations are supposed to inhere in the theory of Müllerian mimicry; these have been most lucidly developed by G. A. K. Marshall (1). Marshall suggests that, for arithmetical reasons, of two equally unpalatable species inhabiting the same region, the less numerous will tend to resemble the more numerous, while the more numerous will not reciprocate

this tendency. (Marshall does not suggest that the more numerous will tend to decrease the resemblance.) The general purport of his paper is to emphasise the Batesian as opposed to the Müllerian factor in mimicry, and that principally for biological reasons, with which only a professed entomologist should deal. The question, however, as to whether there is or is not such a statistical limitation as Marshall claims to the scope of the Müllerian factor, is of the type to which I suggest mathematical reasoning may profitably be applied.

When illustrated by hypothetical type cases nothing is clearer than the distinction between the Batesian and the Müllerian factors; if, however, we ask exactly where the line is to be drawn, it is not too easy to give an answer in terms directly referable to the actual bionomic situation. It is admitted that between two equally unpalatable species only the Müllerian relation is possible, and between a species, which would never be unwelcome (if such exist), and one which would never be attacked, any mimicry must be Batesian; but these are extreme possibilities and Marshall insists, as I hope to show, rightly, that the existence of intermediate degrees of palatability gives increased scope to the Batesian factor. I shall also suggest that in cases involving such intermediate degrees, the Müllerian factor cannot properly be excluded, and that the distinction between the two agencies cannot be drawn offhand without further consideration.

If we imagine three species, occupying the same region, of which A is highly unpalatable, B less so, while C is free from objectionable qualities, then all possible situations may be exhaustively classified as follows (I, II, III, IV), in which, however, the alternative reasons given for the occurrence of any situation (*a*, *b*, *c*), are by no means exhaustive, but might conceivably be much elaborated by detailed biological observations.

I. A, B and C all liable to attack.

II. B and C liable to attack, but not A.

(*a*) Wise and experienced birds, knowing full well the flavours of each species, are hungry enough to attack B, but not hungry enough to attack A.

(*b*) Birds have attacked A and found it to be unpalatable, but have not yet had sufficiently impressed upon their minds the unpalatable qualities of B.

III. A and C liable to attack, but not B.

(*c*) Birds have attacked B and found it to be unpalatable, but have not yet had sufficiently impressed upon their minds the unpalatable qualities of A.

IV. C only liable to attack.

In situation I, mimetic resemblance is without effect, while in situation IV, C would gain by being mistaken for A or B, and A or B would lose by being mistaken for C. C might, therefore, if the former effect were to exceed the latter, become a Batesian mimic of A or B, while, on the contrary, A and B would gain by emphasising their distinctive colouring, if so they could diminish the danger of confusion with C. Similarly, in situation II, A loses by being mistaken for B, and B gains by being mistaken for A; while in situation III the reverse is the case; both A and B will seem, therefore, to be acted upon by opposing tendencies, one tending towards similarity, and the other towards dissimilarity. It is only when the possible situations are analysed into their suggested causes that it is possible to indicate the resultant effect.

For this purpose we distinguish the "Batesian situation" II (*a*), from the "Müllerian situations" II (*b*) and III (*c*), recognising that this classification need not be exhaustive. It is then seen that Batesian situation is to be distinguished by (i) depending upon differences of unpalatability and (ii) producing a "Batesian tendency" for B to approach A and for A to recede from B. While

the Müllerian situations (*b*) and (*c*) do not depend on any difference of unpalatability, but are taken to occur whenever both species are, on occasion, deemed inferior to some alternative food. It is not, however, obvious from the above analysis that the net effect of (*b*) and (*c*) will be to cause a mutual though possibly unequal approach between the two species; such a mutual tendency to approach will be called a "Müllerian tendency." It is Marshall's contention that when the unpalatability is equal, the less numerous species will be attracted by the greater, but the greater will not be attracted by the less. Marshall does not fail to draw from this conclusion a very important consequence, for, as he points out, his premises lead to the inevitable conclusion that, when a mimetic similarity is once effected, the larger species will have gained the smaller share, but still a share, of advantage from the association, and one might be inclined to argue from this that the larger species also will be led to approach this more advantageous condition. The far-reaching conclusion is drawn that such an argument is not valid, unless a continuous path from the first state to the second can be shown to exist, such that the advantage increases for each step along the path. Such a conclusion, if correct, would throw upon the selectionist an onus of detailed demonstration, which his opponent might increase indefinitely by challenging the details with increasing minuteness. Even if the case of Müllerian mimicry were not in itself of sufficient importance, it would be essential to examine in some detail the particular case in which the argument from ultimate advantage is believed to lead to an erroneous conclusion.

Marshall's argument is essentially as follows: if A and B are two equally distasteful species, of which B is the less numerous, then, in the absence of mistakes due to the resemblance of the two species, the young birds will take a proportionately heavier toll of B than of A, before they have all learnt their lesson; consequently any mutant of A which resembles B will suffer more than the non-mutant type, and in consequence will be eliminated. It will be seen that the mutant is supposed to lose the whole of the advantage of the warning colour A, and in return to receive only the less advantage of the warning colour B, and this argument is indeed conclusive in showing that a mutation, which leaps clear outside the protective influence of its type, will suffer heavily for its rashness, even if, miraculously enough, its leap lands it in the heart of the protective influence of a less numerous aposeme. But what of a less violent mutation? Is it possible to gain some of the advantage of resembling B without losing the whole of the advantage of resembling A? Is it even possible that increased shelter from aposeme B will more than counterbalance the loss from decreased shelter from aposeme A? In his answer to Marshall's argument Dixey (2) puts forward a directly opposite supposition, namely that a mutant of appearance intermediate between A and B, would gain the full advantage of both resemblances. In fact, whereas Marshall assumes that the whole of the advantage of resembling A is lost before any of the advantage of resembling B is gained, Dixey assumes, on the contrary, that the whole of the advantage of resembling B may be gained before any of the advantage of resembling A is lost. Both are clearly extreme assumptions; neither can be true generally, and since the two assumptions lead to opposite conclusions it would seem, as far as these arguments carry us, that we are faced with a balance of forces of unknown magnitude, and can neither assert that the Müllerian principle will work, nor that it will fail.

There remains the argument upon which Müller relied, that the final condition of close resemblance being beneficial to both species, both will therefore tend to approach this advantageous condition. Marshall challenges the legiti-

macy of this argument, his reason being the decisive one that he has disproved the conclusion in a particular instance; as we have seen, however, Marshall's argument in the chosen instance is indecisive, and the general argument from the advantage of the final state is in a position to reassert its claims. If it is true, however, it should be possible to devise a form of argument which shall show unequivocally, on the agreed postulates, that the admitted Müllerian situation will in fact produce a Müllerian evolutionary tendency affecting both species concerned.

Such an argument may, I suggest, be constructed by comparing the fate of any deviation from the type A, not with the average type, but with an equally conspicuous but opposite deviation. It will be admitted that variations of the species A, whether due to mutation or to Mendelian recombination, will be equally frequent in the direction of B as in the opposite direction; we may, therefore, without error, consider such variations to occur in pairs comprising variations of equal magnitude, but in opposite directions. Since they are of equal magnitude they will lose (if anything) equally by failing to be recognised as typically A, but if either, or both, are ever mistaken for species B, the greater benefit will certainly be reaped by the variation in the direction of B. Since the whole species may be regarded as made up of such pairs of variations, and since in every pair selection favours the one more like B, if either is favoured, the net resultant must be a modification in the direction of species B.

It will be seen that the condition for the existence of a mimetic tendency is that in a certain proportion of the situations in which A is liable to, but B is immune against attack, members of species A should, through their similarity to B, actually escape attack. This is somewhat different from the condition arrived at by Prof. H. H. Turner, who speaks (7) of an actual overlap of the variations of the two species as the condition for the efficacy of Müller's statistical argument. The possibility of error on the part of the predator seems an essential feature in mimicry theory, and allowance can be made for it in Turner's treatment, provided we interpret his distribution curves as referring, not to the objective variability of the species, but to the (probably much greater) variability of the predator's subjective impressions, influenced as these must often be by inattention or haste, and by deceptive or insufficient illumination—in fact, by whatever circumstances conduce to error, human or avian. It is rather remarkable that, on a subject so remote from direct evidence as the subjective impressions of birds, we should possess three good reasons for assuming an approximately normal distribution : (*a*) that the reasons for which this distribution is chosen as the "normal law of errors" can scarcely be confined to mankind, (*b*) that the objective variability of a measurable character due either to Mendelian segregation, or to environmental fluctuations, is usually closely normal, and (*c*) that the resultant compounded of two independent distributions is necessarily more normal than one, and possibly than both of its components.

The argument above developed may assuredly be refuted by disproving any of the biological factors assumed in the discussion. If it were proved that situations never in fact arise in which a member of A would survive if mistaken for B, but would perish if not so mistaken, that no predator learns by experience or is ever influenced by mimetic resemblances, or that such variations of A as do favour the resemblance are not heritable, then the Müllerian theory of mimicry would fail as an explanation of the resemblances observed. The sole point established by the above reasoning is that if these biological factors are admitted the resulting evolutionary tendency cannot be confined to the less numerous of two species. The efficiency of Müllerian selection will doubtless be greater

(*ceteris paribus*) with the smaller species, but the supposed statistical objection to the Müllerian attraction of a larger species (or group) by a smaller is wholly fictitious.

III. The Theory of Saltations.

Punnett (3, Chap. VI, pp. 72–74) repeats Marshall's argument, and concludes without reservation that Müllerian mimicry of a less numerous by a more numerous species is excluded by it. At first sight the argument appears irrelevant to Punnett's main contention of the inadequacy of Natural Selection to produce adaptations, for he evidently, unlike Marshall, would reject also both Batesian mimicry, and the Müllerian mimicry, of the more numerous by the less numerous species. Nevertheless, it would not be altogether fair to regard Punnett's citation of Marshall's argument as a merely extraneous addition to his indictment, such as by arousing suspicion of error, though on an irrelevant issue, might serve to secure a verdict on the main count; on the contrary Marshall's argument plays a small yet essential part in his destructive argument derived from mimicry rings. The case of two presumably palatable female types each quite unlike the corresponding males, which males are unlike each other, is chosen to illustrate this difficulty. The two females show an apparent mimetic resemblance to three other butterflies, two regarded as definitely unpalatable and the third as doubtfully so. Assuming that the non-mimetic males represent the former appearance of the two mimetic females, it is asked how the latter have come to resemble the distasteful members of the ring. Granted that these models might once have been not unlike in appearance to one of these males it can scarcely be assumed that they ever resembled both, either simultaneously or consecutively; but unless such a resemblance formerly existed a *gradual* mimetic evolution is precluded, and we should be forced to admit that the mimetic females arose as sports or saltations totally unlike their mothers. (The word "saltation" is used here in preference to "mutation" since the modern Mendelian usage of the latter word contains no suggestion of a pronounced difference. Mutations may be changes quite small compared to the individual variability of the species.)

It will be seen that for Punnett's argument on this important point, the gradual and mutual convergence of two or more different warning colours must be wholly excluded, for if the possibility of such a process is admitted the difficulty of imagining a continuous sequence of changes entirely disappears, while on the contrary the assumption of discontinuity becomes a burden upon the theory, involving as it does the definite improbability of hitting off a good resemblance at one shot. Consequently Marshall's argument, which Punnett seems to have taken as reimposing all the limitations of the Batesian situation, plays an essential part in the argument in favour of saltations; so essential indeed that it seems impossible to repair the breach made by its removal.

The case for saltations as presented by Punnett was not entirely negative and destructive in character; it embodied one (then) recently discovered fact of considerable interest, namely that the differences between the three forms of the trimorphic female of *Papilio polytes* could be ascribed to two Mendelian factors, both limited in their obvious effects to the female sex, and one apparently necessary for the manifestation of the second.

This fact is of importance as indicating the mechanism by which a clear polymorphism is maintained; it shows that polymorphism in this case, and probably in similar cases, is dependent on one or more Mendelian factors the function of which is to switch on one or other of the possible alternatives, just

as the more widespread dimorphism of sex is also dependent upon the Mendelian mechanism. In some groups, e.g. *Drosophila* and Man, a whole chromosome is utilised in the process of sex determination, in some fishes, on the contrary, (6), crossing over has been found to occur between the "sex-chromosomes" in the male (the heterogametic sex in this group), and we evidently ought more properly to speak of the sex gene rather than the sex chromosome as the agent of sex determination. The passage from the one condition to the other, by the cessation of crossing over, presents no inherent difficulties, especially as Mendelian factors are known which expedite or inhibit crossing over. The reason for such a change is not so obvious, but since both systems are found still in use, it is probable that each has, upon particular conditions, its own advantages.

The core of Punnett's argument in favour of the production of mimetic forms by saltations lies in the Mendelian behaviour of the polymorphic females, for it is argued that these Mendelian factors must have arisen originally as mutations, and seeing that the different forms demonstrably differ by only single factor differences, these types must have sprung into existence each at a single leap. Convincing as this argument at first sight seems, we should, nevertheless, at once recognise our folly if we argued that because the sex difference in *Lebistes* is apparently determined by a single factor, therefore a female fish of that genus, with the appropriate adaptations of her sex had arisen by a single saltation from a male of the same species! Or *vice versa*. In this case we are freed even from the necessity of rejecting the supposed saltation as improbable, for since the reproduction of the species requires the co-operation of both sexes, we may be certain that the origin of the sex factor antedated the evolution of separate sexes, and has persisted, in its function of switch, unchanged during the whole course of the evolutionary development of these two types.

The example of sex emphasises strongly the fact that it is the function of a Mendelian factor to decide between two (or more) alternatives, but that these alternatives may each be modified in the course of evolutionary development, so that the morphological contrast determined by the factor at a late stage may be quite unlike that which it determined at its first appearance. The inference, therefore, that because a single factor determines the difference between a mimetic and a male-like form in *P. polytes*, therefore the mimetic form arose fully developed by a single mutation, is one that cannot fairly be drawn; it requires, in fact, the gratuitous assumption that no evolutionary change has taken place in the two alternative forms since the dimorphism was first established.

Certain genetical experiments have demonstrated that genetic changes of the kind here considered are compatible with a purely Mendelian scheme of inheritance. In rats, the hooded (black and white) pattern is a simple recessive to the "self" or "solid" coloration; the case is probably parallel to the "Dutch" pattern in rabbits, and the "recessive pied" in mice. In studying variations in the hooded pattern Castle (4) found that by selection it was easy to obtain strains of hooded rats which were almost entirely black, and other strains almost entirely white, and equally, of course, a large number of stable patterns of an intermediate character. All these types of "hooded" behaved as before, as simply recessive to self-colour. Two possible explanations were put forward; the first possibility was that the modification produced by selection lay in the hooded gene, that, in fact, selection had sorted out from a large number of slightly differing allelomorphs, those favouring much or little pigmentation, and consequently that the surviving hooded genes had been modified by selec-

tion; the second possibility was that the hooded gene was invariable in character, but that the pigmented area depended also on the co-operation of other genes, so-called modifying factors, and that the change in the hooded pattern was the result of selection, among the alternatives presented by these modifiers, of those types which developed larger or smaller pigmented areas respectively. A crucial experiment was devised to decide between these possibilities. Rats of both selected lines were bred back to unselected selfs, the young were inbred, and the hooded pattern was recovered in the grandchildren; if the modification had taken place in the hooded gene the recovered hooded rats would have received fully modified hooded genes, and must have been as dark as the hooded line from which they were obtained; but, if other factors were responsible, the hooded grandchildren would have received these equally from their self and from their hooded grandparents, and would consequently be less dark than the latter. The second alternative was proved to be correct, the modification being readily transmitted by self-rats which contained no hooded gene. The gene, then, may be taken to be uninfluenced by selection, but its external effect may be influenced, apparently to any extent, by means of the selection of modifying factors.

Unless the above analogies are wholly misleading, we should suppose that the factors H and R which Fryer (5) found to determine the differences between the polymorphic forms of *P. polytes*, each arose suddenly by a mutation, and that the new genes so produced have been entirely unmodified since their first appearances. On the other hand, we should see no reason whatever on genetic grounds to believe that the combination HHrr on its first appearance at all closely resembled the modern form *polytes*, or was an effective mimic of *P. aristolochiae*; nor that the combination HHRR resembled the modern form *romulus*, or was an effective mimic of *P. hector*. The gradual evolution of such mimetic resemblances is just what we should expect if the modifying factors, which always seem to be available in abundance, were subjected to the selection of birds or other predators.

IV. Stability of the Gene-ratio.

It should be emphasised that there is nothing in the above argument which helps to explain polymorphism itself. The phenomenon is sufficiently uncommon to suggest that it must always owe its origin to some rather special circumstances; however, the Mendelian character of the phenomenon does suggest one short step in the direction of a solution, namely, that the underlying condition for its development is that the proportionate numbers of the genes of some Mendelian factor, having a fairly marked effect, should be in stable equilibrium. By stable equilibrium I wish to imply that, if this ratio is disturbed from its equilibrium value it will automatically tend to return to that value, in whichever direction the disturbance takes place. Both Fryer and Punnett speak of the proportion of the Mendelian types being in stable equilibrium, in the absence of selection, and for particular values of the frequency ratio of the genotypes. Thus it seems to have been believed that the ratio is particularly stable if 44 per cent. are recessive, and this is compared with the observed percentage, 45, as an indication that the species is in a stable state. It should be stated emphatically, firstly, that in the absence of selection the equilibrium of the gene-ratio is neutral, and is not properly described as stable, for on disturbance there will be no tendency to recover its former value; and, secondly, that all possible ratios either for the genes, or for the genotypes are

on exactly the same level, no ratios being specially favoured. The only point to which, in this system, the term stability can properly be applied, is the ratio of the number heterozygous to the geometric mean of the numbers homozygous, and of this ratio there is no experimental evidence available; barring restrictions on random mating of a most drastic character, this ratio can scarcely differ much from its stable value, two.

That a genuine stability probably characterises the gene-ratio in polymorphic species appears probable from the consideration of the time required for a single mutation to increase sufficiently in numbers till it affects, say, one-third of the genes of the species. In the absence of selective advantage this time will be that of a number of generations of the same order as the number of individuals which there are in the species; for many species this would be at least a thousand times as long as the longest time allowable. In order to affect a considerable portion of the population within a reasonable time the new gene must enjoy a selective advantage. If this advantage were to continue, however large a proportion of the population were occupied by the favoured gene, the process would be continued until the extermination of its allelomorph, and no dimorphism would remain. Only if the selective advantage wanes with increasing numbers, disappears at a fixed ratio, and beyond that is reversed, will a true stability of the gene-ratio be established. Stability is thus not only evidence of selection, but of the dependence of selective advantage upon the actual ratio of the alternative types.

Stabilising selection can scarcely be other than exceptional, yet it may be expected to arise in several ways. A Batesian mimic, for example, will receive less protection, the more numerous it is in comparison with its model; a dimorphic Batesian mimic will therefore adjust the numbers of its two forms, if these are dependent upon a single Mendelian factor, until they receive equal protection; any increase in the numbers of one form at the expense of the other would diminish the advantage of the former and increase that of the latter, thus producing a selective action tending to restore the original proportion. Note that a mimic owing its advantage to Müllerian situations only should not be dimorphic unless additional causes of stability are at work, for apart from these the selection produces an unstable equilibrium, from which the ratio will continue to depart until one or other type is exterminated.

A second form of stabilising action is found in reproductive selection. The stable ratio of the sexes is clearly due to this cause, as is that of the thrum-eyed and pin-eyed primroses. It is interesting to note that Fryer, in his breeding experiments with *Papilio polytes* observed numerous cases of sterile unions, which suggested to him the possible existence of "illegitimate" pairings. One of the simplest possibilities of this type is a merely greater fertility of the heterozygous as compared to the homozygous condition. As I have shown elsewhere, (8), the stability in the gene-ratio of factors for which the heterozygote is favoured, affords also a possible explanation of the phenomenon of "hybrid vigour."

It should perhaps be noted that Gerould's work (9), on the dominant white observed in the female of several species of *Colias*, also reveals some peculiar features suggestive of a stability mechanism governing the yellow-white gene-ratio. Gerould reports that great difficulties were encountered in obtaining the homozygous white types, these difficulties being evidently connected with the occurrence of a closely linked lethal factor. When pure white broods had been obtained, from a strain freed from the lethal, the failure of the males to mate caused the introduction of wild males, and these were found to bring in the

lethal factor. The fact that this particular lethal is not apparently rare in nature, although we should expect it to die out somewhat rapidly, suggests that a stabilising system must be present. The genetic complexities are not fully elucidated, for certain types of mating seem regularly to give an abnormal sex-ratio (3 ♀ : 2 ♂). It is interesting in connection with the modifying effects of selection, that Gerould notes the occurrence of a fluctuating tinge of yellow on the wing of the genetically white female, and ascribes its variability to secondary factors.

Cases such as those of *P. polytes* and *Colias* have an additional special interest, in that the stability mechanism probably involves both the reproductive elements of genetic lethality and sterility on the one hand, and on the other hand, elements involved in the differential adaptation, of the forms concerned, to survival in their wild environments; for if these latter were absent we should expect the gene-ratio to be the same in all localities. The unique possibility therefore presents itself of obtaining a direct measure of the selective value of such differential adaptation by equating it to the calculable effects of the reproductive selections, against which we find it in nature balanced. The importance of such a direct determination need scarcely be emphasised; the hindrances to free reproduction in these groups have appeared hitherto merely as an obstacle impeding the Mendelian analysis of the polymorphic forms; it is much to be hoped that, in view of the application outlined above, their elucidation may, in future studies, be made a principal object of research.

Whatever be the cause to which a factor owes its stability, any species in which a stable factor occurs will be potentionally dimorphic, and permanently so unless in changed conditions the stability can be upset. If, in this condition, selection favours different modifications of the two genotypes, it may become adaptively dimorphic by the cumulative selection of modifying factors, without alteration of the single-factor mechanism by which the dimorphism is maintained.

Summary.

1. The contention of Marshall that statistical reasons preclude the action of selection from favouring the modification of a more numerous species in the direction of a closer resemblance to a similar but less numerous species, is without valid foundation.

2. The contention of Punnett that mimicry rings containing more than one palatable mimic, much modified from its primitive appearance, must have arisen by discontinuous saltation depends wholly on the validity of Marshall's argument.

3. The Mendelian behaviour of the different forms of a polymorphic species does not prove that these forms arose by single saltations.

4. The stability of the gene-ratios of factors controlling polymorphism implies a selective action, reproductive or other, influenced by the frequency-ratio of different forms. Any factor causing visible differences, and possessing a ratio of stable equilibrium, will provide a potential dimorphism capable of evolutionary development by the selection of modifying factors.

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A NEW FAMILY OF AQUATIC HETEROPTERA

By Teiso Esaki and W. E. China.

[Read October 5th, 1927.]

With Ten Text-figures.

During the recent British Museum Expedition to Tanganyika, under the leadership of Dr. C. Christy, a considerable collection of aquatic animals was made by Mr. S. R. B. Pask. Amongst this material are numerous specimens representing two remarkable new genera of water-bugs, *Idiocoris*, nov., and *Paskia*, nov. A study of these insects has thrown considerable light on the relationships of the genus *Helotrephes*, Stål, and it is now evident that a new family, Helotrephidae, must be erected to hold the three genera. The authors desire to express their thanks to Mr. B. Jobling, of the Wellcome Bureau of Scientific Research, for his assistance in the preparation of microtome sections of the antennal structure in the new forms, and to Mr. A. J. E. Terzi, who has spent much of his valuable time on the drawings illustrating this paper.

In 1859 Stål * described a new genus of aquatic Heteroptera, *Helotrephes*, in which the most striking feature was the almost indistinguishable suture between the head and pronotum. Although four more species were later described by various authors, it was left for Bergroth † to point out in 1918 that, " in this genus the head is not independently moveable, being practically fused with the thorax, forming (as in the Arachnida) a cephalothorax." In spite of this important character, which is apparently unique among insects, *Helotrephes* was placed in the Notonectidae near *Plea*, Leach. In the two new genera discovered by Mr. Pask in Lake Tanganyika, the fusion of the head with the pronotum is almost complete, and the suture is invisible in the imago. From a study of their structure, it is now evident that *Helotrephes*, *Idiocoris* and *Paskia* form a natural group, characterised by the fusion of the head and pronotum, by the strongly asymmetrical male genital segments, and by the segmentation of the tarsi, which is 1–1–2 respectively.‡ It is proposed to call this group **Cephalonotera** series nov., and its phylogeny will be discussed later.

The morphology of *Helotrephes* has never been studied in detail, although six species are now known from the Indian, Malaysian, Oriental and Mascarene regions. Previous authorities, including Bergroth, have all regarded the genus as closely related to *Plea*, Leach, but, from detailed examinations made by the present writers, it is obvious that *Helotrephes* can not remain in the same family with *Plea*, which it only superficially resembles. Not only are the head and pronotum fused, but the antennae are only two- instead of three-segmented, the scutellum is larger, the tarsal joints consist of 1–1–2 segments respectively, instead of 3–3–3,§ the male genital segments (7th, 8th and 9th abdominal) are twisted to the left, and strongly asymmetrical, the females have no ovipositor,

* Stål, Freg. Eugenie. Resa, Hemipt., p. 267, 1859.

† Bergroth, Phil. Journ. Sci., (D) xiii., p. 125–126, 1918.

‡ Almost all authors have regarded the segmentation of the tarsi in the Ochteridae and Gelastocoridae as 1–1–2, but actually in the former the segmentation is 2–2–3, and in the latter 1–2–3. In *Notonecta* the segmentation is 3–3–2, not 2–2–2 as stated by Reuter.

§ The segmentation of the tarsi in *Plea* is usually inaccurately regarded as 2–2–2.

and the larvae possess a single unpaired median dorsal abdominal gland opening on the second tergite.

Family **HELOTREPHIDAE,** nov.

Water-bugs of small size. Head and prothorax completely fused together, the boundary between them indicated by a shallow linear impression in imagines, incomplete in *Idiocoris* and *Paskia*. Antennae much reduced, two-segmented ; in *Idiocoris* and *Paskia* only a single segment represented by a flat oval disc furnished with a number of long setae. Eyes small, elongate, imbedded dorso-laterally in cephalonotum, scarcely extending ventrally. Ocelli absent. Rostrum four-jointed. Scutellum strongly developed, very large. Elytra reaching the apex of abdomen, interlocking along apical margin, corium and clavus usually fused, but sometimes in *Helotrephes* separated by a suture in which case the hind-wings are well developed; no distinct venation, membrane represented only in left elytron by a small interlocking structure. Hind-wings usually absent, or represented only by a very small vestigial structure; sometimes present in *Helotrephes*. One tarsal joint in anterior and intermediate legs, two in posterior legs, all tarsi with two equal claws. Abdomen with ten segments, six abdominal (first segment is not visible), three modified genital, and one anal. Male genital segments strongly asymmetrical. Larvae with a single unpaired dorsal abdominal gland opening on the second tergite.

Type genus : *Helotrephes*, Stål.

The family may be divided into two distinct subfamilies distinguished as follows :—

General form globose, surface shining; suture between head and pronotum distinctly visible as a w-shaped line extending between the posterior internal angles of the eyes; antennae two segmented; cephalonotum long and strongly inflexed, its margins feebly sinuate; scutellum short and broad, its margins convexly sinuate . . . . . **HELOTREPHINAE**, nov.

General form not globose, rather flattened, surface dull not shining; suture between head and pronotum absent, visible in larva as ω-shaped line extending between middle of internal margins of eyes; antennae represented by a single flat disc-like segment; cephalonotum relatively short, less strongly inflexed, its lateral margins more or less strongly concavely sinuate; scutellum long and narrow, its lateral margins almost straight . . . . **IDIOCORINAE**, nov.

Subfamily **HELOTREPHINAE.**

Genus **Helotrephes,** Stål.

1859. Stål, Eugenie's Resa, Hemipt., p. 267.
1904. Kirkaldy, Wien Ent. Zeit., 23, p. 129.
1910. Distant, Faun. Brit. Ind. Rhyn., 5, p. 338.
1918. Bergroth, Phil. Journ. Sci., 13, Sec. D, pp. 125–126.

Genotype : *H. semiglobosus*, Stål.

The existing descriptions of *Helotrephes* and its species are very poor, and quite inadequate for identification. It is very probable that some of the species which have been referred to this genus are not congeneric with *H. semiglobosus*, Stål. Six species have already been recorded, and in the British Museum there are several more as yet undescribed. The biology of the subfamily is almost unknown. *H. indicus*, Distant, was taken from a muddy pond at Rangoon * in February, and Mr. Cedric Dover has taken other species from

* Distant's statement to the effect that *H. indicus* was found in tanks at Calcutta is quite inaccurate. In the type series which is from Rangoon, Burma, there is a single specimen labelled Calcutta, Museum tank, 14.viii.1906. This is actually a larva of *Plea pallescens*.

ponds near Kuala Lumpur, Federated Malay States, in June, July and August.

1. *Helotrephes semiglobosus*, Stål.

1859. Stål, Eugenie's Resa, Hemipt., p. 267, taf. 3, fig. 7.

Habitat : China (Wampoa).

2. *Helotrephes eremita*, Horv.

1899. Horváth, Termész. füzetek, 22, p. 268.
1899. Kirkaldy, Ann. Soc. Ent. France, 1899, p. 108.

Habitat : Madagascar (Baie d'Antongil).

3. *Helotrephes bouvieri*, Kirk.

1904. Kirkaldy, Wien. Ent. Zeit., 23, p. 129.

Habitat : Celebes.

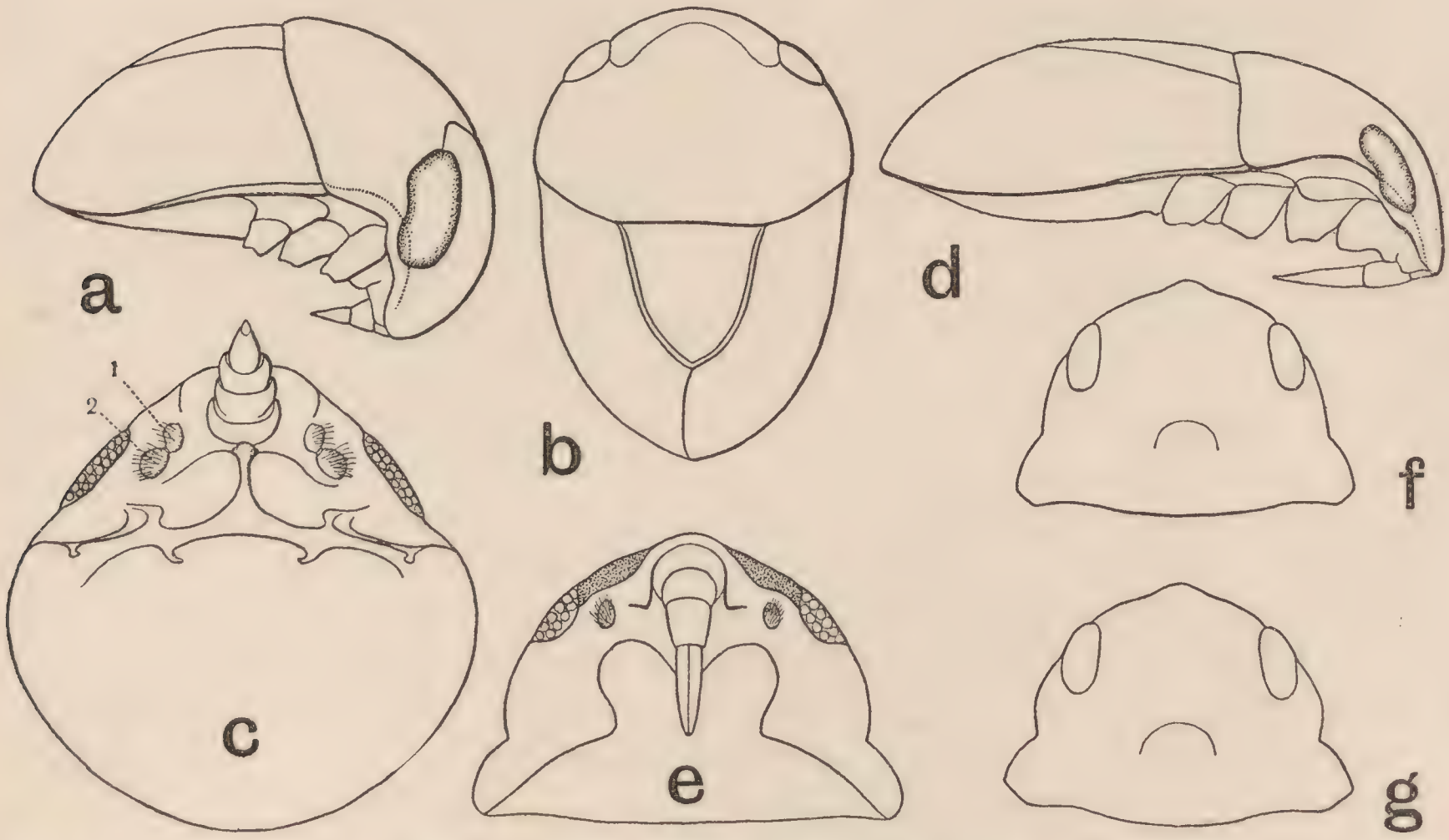

Fig. 1.—a. *Helotrephes indicus*, Distant, lateral view (only coxae present); b. same, dorsal view, showing suture between head and pronotum and broad scutellum; c. same, underside of cephalonotum showing position of two-segmented antennae (rostrum shown in vertical position); d. *Idiocoris lithophilus*, Esaki and China, lateral view (only coxae present); e. same, underside of cephalonotum showing rostrum and position of antennal plates; f. dorsal view of cephalonotum of male; g. dorsal view of cephalonotum of female; note sexual difference in degree of lateral constriction. (Drawings all diagrammatic.)

4. *Helotrephes martini*, Kirk.

1904. Kirkaldy, *loc. cit.*, p. 130.

Habitat : Sumatra (Palembang).

5. *Helotrephes indicus*, Dist.

1910. Distant, Faun. Brit. Ind. Rhyn., 5, p. 338, fig. 199.

Habitat : Burma (Rangoon). (Not Calcutta as stated.)

6. *Helotrephes balnearius*, Bergr.

1918. Bergroth, Phil. Journ. Sci., 13, Sec. D, pp. 125–126.

Habitat : Philippines (Luzon; Laguna, Los Baños).

Subfamily **IDIOCORINAE.**

Genus **Idiocoris,** nov.

Both sexes of same length. Body oval, moderately convex dorsally, flat ventrally; surface dull, not at all shining; in profile the dorsal outline arcuate. Head and pronotum fused together into a single sclerite (cephalonotum), the boundary between them very obscure. Anterior portion of cephalonotum coarsely covered with long stout hairs. Eyes imbedded dorso-laterally in cephalonotum, scarcely extending ventrally, much smaller and more elongate than in *Helotrephes*, facets coarse. Ocelli absent. Antennae represented by a shallow depression containing an oval disc furnished with long setae, and with a circular tubercle near apical margin. Rostrum four-jointed, reaching the anterior coxae, first joint arising between prominent lateral lora, very short, second and third longer than first, fourth much the longest and the most slender, provided below apex with a short median lobe or labellum. Prothorax fused with head both dorsally and ventrally, posterior margin truncate, lateral margins strongly constricted, the carinae between notum and sternum very prominent. Scutellum long and narrow, triangular, the apex passing the middle of abdomen. Elytra very well developed, covering the whole abdomen, no distinction between corium and clavus, no distinct venation, membrane represented by an interlocking device. Pro- and mesosternum strongly carinated down middle. Legs ambulatory, rather short, coxae large and thick, femora stout; tibiae shorter than femora in the anterior two pairs, longer than latter in the posterior pair; tarsi one-jointed in anterior two pairs, two-jointed in posterior pair, all tarsi with two equal claws. Intermediate femur with a row of very stout spines along the inferior margin. Posterior tibia and tarsus with two rows of long stout "swimming" hairs. All tarsi with a pair of bristle-like arolia inserted in a serrated basal structure. Abdomen with five visible segments (second to sixth), three genital segments and one anal segment (visible only at high magnifications); the second abdominal ventral segment, very short at middle, almost divided into two parts, the narrow median region with a carinate process, extending anteriorly between the posterior coxae, the third segment also short and in the middle with a more or less conical tubercle. The sutures between the sternites not continuous with those separating the corresponding pleurites, but directed more anteriorly (see fig. 6).

Type: *Idiocoris lithophilus*, sp. nov.

Idiocoris lithophilus, sp. nov.

Colour. ♂, ♀. Pale sordid yellow with markings on cephalonotum dark brown, the scutellum and elytra greyish brown. Cephalonotum pale sordid yellow with a broad transverse band between eyes, a broad longitudinal stripe extending from the apex of head to the middle of transverse band, and a broad stripe along posterior margin of pronotum, dark brown. Eyes black. Rostrum pale sordid yellow. Scutellum greyish brown, with base and apex obscurely pale yellow. Elytra dark greyish brown with apices rather broadly yellowish white. Sternum, venter and legs pale sordid yellow.

Structure. ♂. Body oval, stouter in the posterior half, moderately convex dorsally, flat ventrally. Head and pronotum more or less completely fused, forming cephalonotum. Cephalonotum bell-shaped, one and one-third times as broad as long (55 : 41), slightly obtusely produced apically above the insertion of rostrum, lateral margins below the eyes moderately constricted, posterior margin broadly convexly rounded with an obscure angular sinuation on each side of base of scutellum. Anterior portion (head) of cephalonotum sparsely covered with long pale hairs; the anterior margin between eyes and base of rostrum minutely granulate, ventral surface with a number of small spine-like bristles on each side of rostrum below the lora; head obscurely distinguished from pronotum by

shallow indistinct linear depression along posterior margin of transverse brown band between eyes; another similar semicircular depression on middle of pronotum. Eyes almost entirely dorsal, only about one-seventh of their area (8 facets) ventral, one and a half times as long as broad (3 : 2), posterior half backwardly produced and fused within the pronotum, facets large, about 50 in each eye; surface feebly convex; distance between

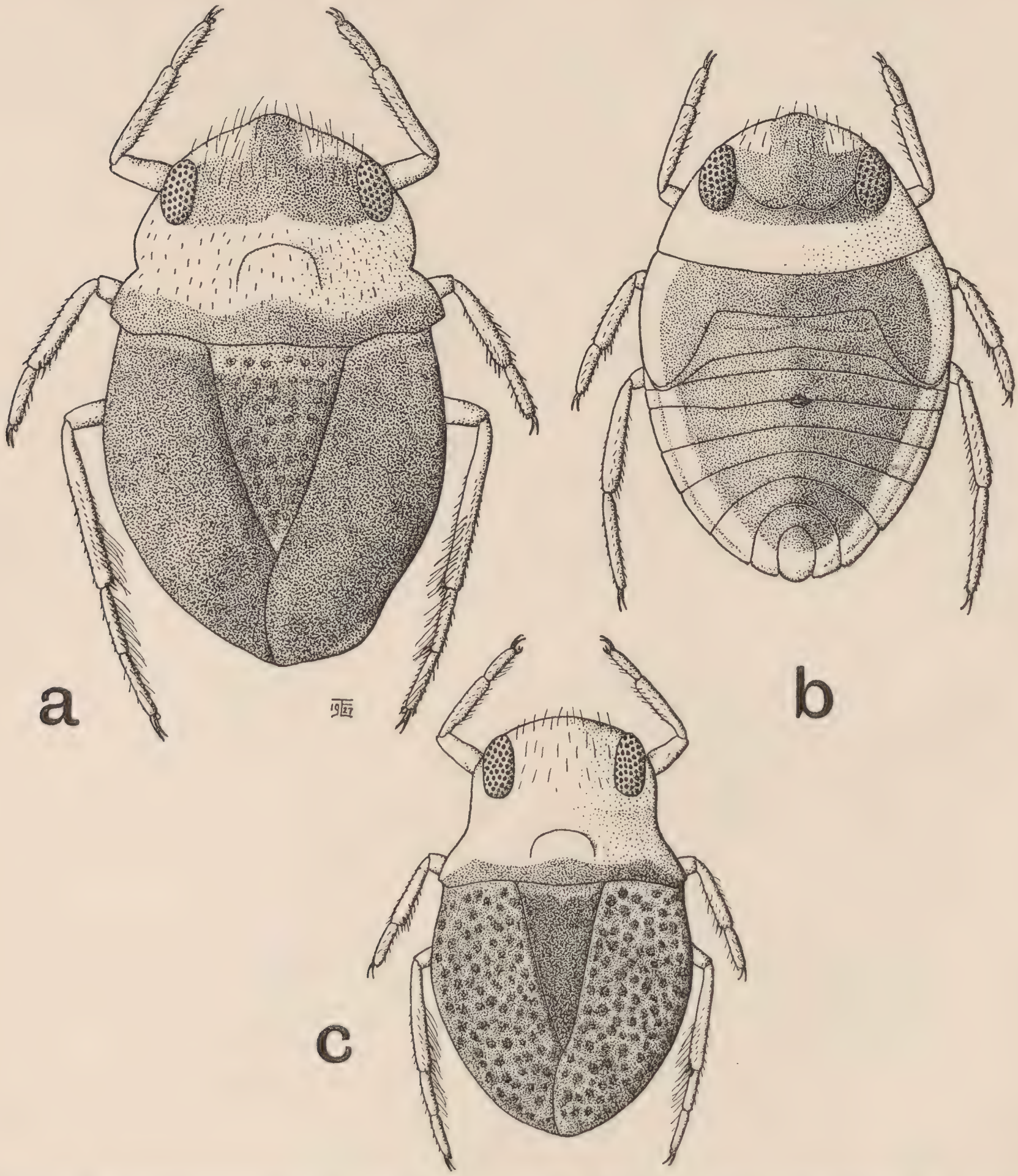

Fig. 2.—a. *Idiocoris lithophilus*, Esaki and China, female, Lake Tanganyika; b. larva of same; note single opening of dorsal abdominal gland, and position of suture separating head and pronotum; c. *Paskia minutissima*, Esaki and China, female, Lake Tanganyika.

the eyes nearly four times the breadth of one eye seen from above (17 : 27). Rostrum four-jointed, the first two segments short and broad, inserted between two very prominent foliaceous lora, and with the base covered by the slightly overlapping clypeus; second joint half the length of first, only visible in microscopic preparations; third segment narrower tapering towards apex much longer than first, with a distinct constriction near its base which telescopes into the second; fourth longest, more than twice as long as third, more slender, tapering to apex; ratio of length of segments 4 : 2 : 5 : 12; below apex of

fourth segment is a short median lobe or labellum; labrum absent. Antennae replaced by a pair of shallow oval pits placed one on each side of the ventral surface of head between base of rostrum and eye, each pit completely filled by a flat disc-like structure, the surface of which is covered with long setae, and bears a curious circular organ near apical margin. Scutellum long, rather narrow, triangular, two and a half times as long as broad at base (5 : 2), lateral margins almost straight, but converging more strongly towards the apex, very sparsely covered with pale depressed hairs arising from concolourous punctures. Elytra thick and leathery, strongly convex, apices more or less rounded, sparsely, but distinctly punctate, a very minute hair arising from each puncture (invisible at low magnification); covering the whole abdomen, the costal margins more or less symmetrical, venation obsolete,

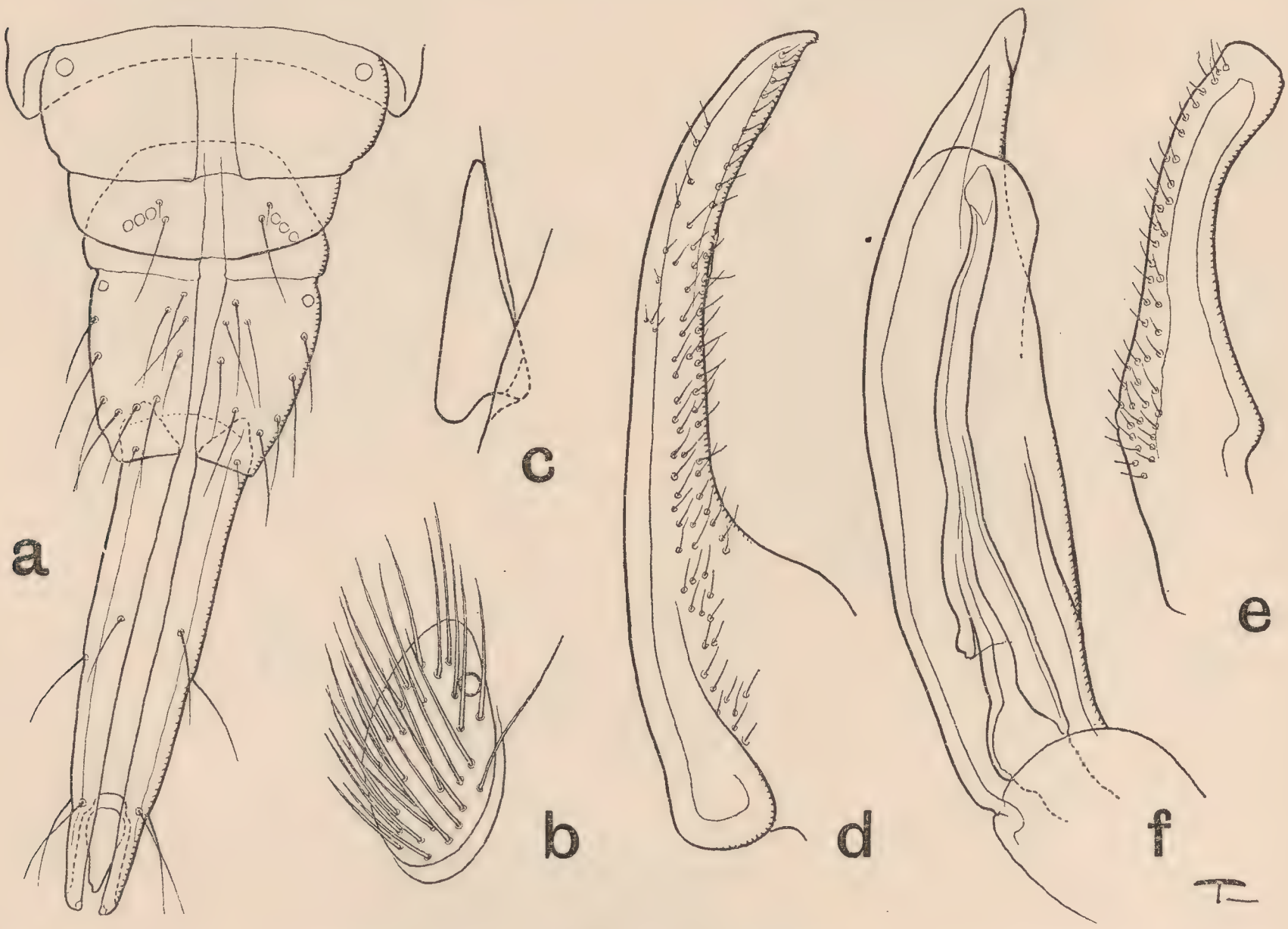

Fig. 3.—*Idiocoris lithophilus*, Esaki and China: a. rostrum showing apical labellum; b. antennal plate; c. longitudinal section through antennal plate (microtome section), showing problematical basal segment; d. right-hand (ventral) paramere; e. left-hand (dorsal) paramere; f. aedeagus (for diagrammatic interpretation of aedeagus see fig. 8).

clavus fused with corium, but with a claval suture obscurely denoted by a dark stripe of thickened chitin; the left elytron with a narrow parchment-like membranous structure separated from the hyaline apical margin of corium by a distinct vertically elevated ridge; right elytron without such a structure, but with a distinct ridge along underside of apical margin which interlocks with that of the left elytron, the right always overlapping the left; a small area at the extreme base of the elytron just below the point of attachment minutely granulated (invisible at low magnification), underside of costal margin just below the base provided with a groove with ∩-shaped strongly chitinous wall, into which fits a postero-laterally directed process of the mesopleuron. Hind-wings absent, but represented by a small membranous vestigial process of the metanotum. Pro- and mesosternum each with a strongly elevated laminate median longitudinal carina of conical outline viewed laterally; only lateral portions of metasternum visible, second (first visible) ventral abdominal segment extending anteriorly as a strongly elevated laminate carina between posterior coxae. Thoracic spiracles, as is usual in Heteroptera, present on the membrane between pro- and

mesothorax. Anterior legs: coxa moderately incrassate, about twice as long as broad; trochanter short; about half as long as coxa; armed towards apex with four or five comb-headed bristles; femur moderately incrassate, about four and a half times as long as broad (14 : 3), the anterior edge of the inner side armed along the basal three-quarters with an irregular band of comb-headed bristles interspersed with three pointed spine-like bristles; tibia a little shorter than femur (6 : 7); apical three-quarters of anterior edge of inner side armed with a row of pointed spine-like bristles, flanked along outer side by a row of comb-headed bristles; apical two-thirds of posterior edge of inner side armed with a row of pointed spine-like bristles; tarsus single-jointed about half the length of tibia (12 : 23),

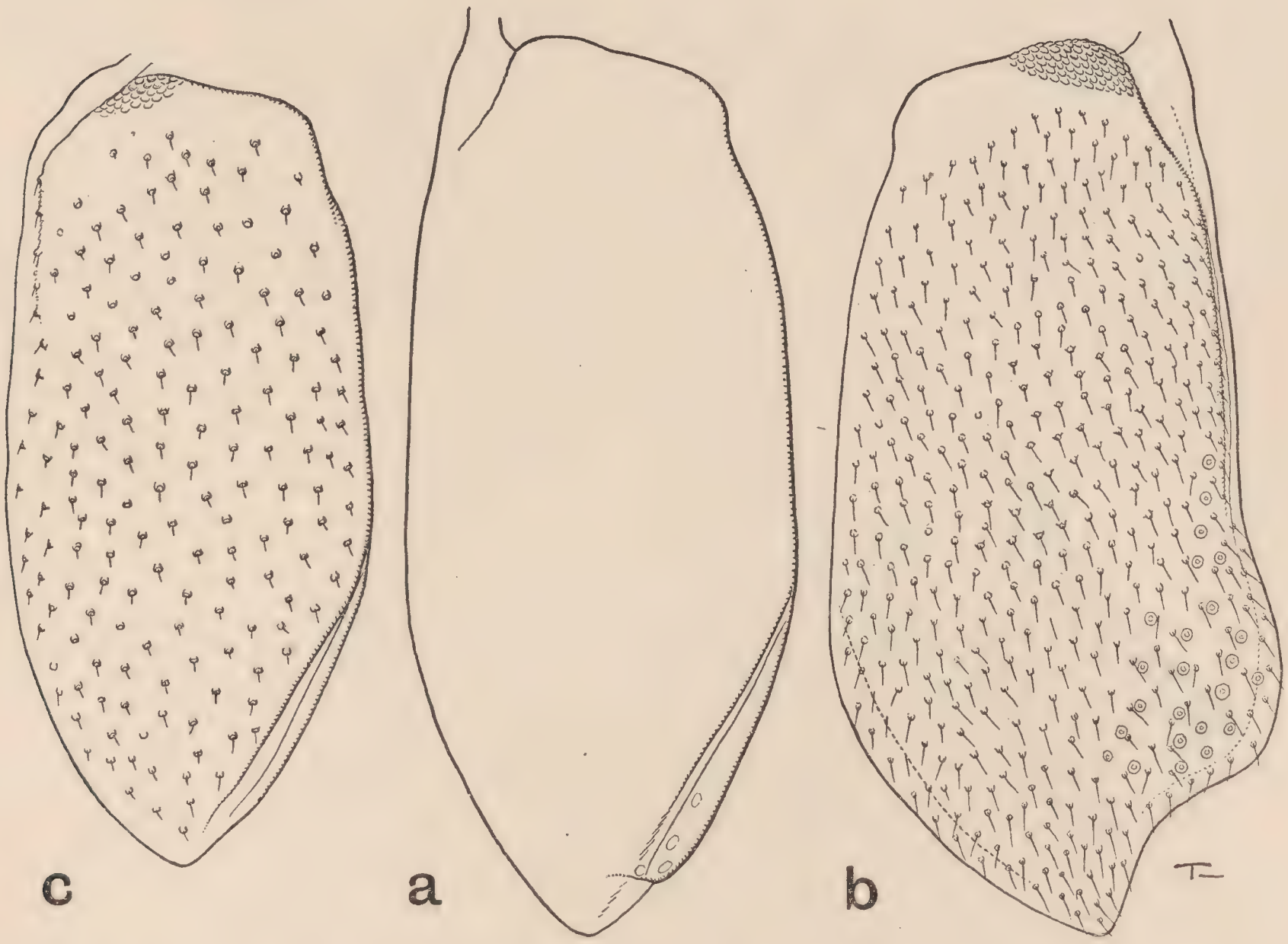

FIG. 4.—a. *Idiocoris lithophilus*, Esaki and China, female, left-hand hemi-elytron showing fusion of corium with clavus, and apical interlocking groove; b. right-hand hemi-elytron of same (viewed obliquely from side), showing the asymmetrical lobe bearing sensory organs, pilosity, and granulation of base (the apical interlocking ridge is shown as a dotted line); c. *Paskia minutissima*, Esaki and China, female left-hand hemi-elytron showing apical interlocking groove and pilosity.

inner side armed along anterior and posterior edges with two rows of spine-like bristles; claws about one-third the length of tarsus at their base, with two bristle-like arolia and a median long slender membranous pulvillus. Intermediate legs: shorter than anterior legs; coxa one and a half times as long as broad; trochanter about two-thirds the length of coxa, posteriorly minutely tuberculate, and with several spine-like bristles; femur a little longer than anterior femur, broadest at the base, armed on underside with two rows of spine-like bristles, the posterior row consisting of fourteen moderately robust spines extending along basal two-thirds of femur, reducing in size towards the apical end of the row; anterior row extending the whole length of femur, consisting of much finer bristles; tibia much shorter than femur (5 : 7), armed rather irregularly with rows of comb-headed bristles, pointed spine-like bristles and a few long hairs, the longest spines at the apex; tarsus single-jointed, three-fifths the length of tibia, furnished with two irregular rows of pointed

spine-like bristles; claws rather less than half the length of tarsus, similar in shape to anterior claws. Posterior legs much the longest; coxa large, less than twice as long as broad, armed towards apex with a few pointed bristles; trochanter more than half as long as coxa, unarmed; femur slightly longer and much more slender than intermediate femur, about five times as long as broad (6 : 29), armed along the ventral edge of the inner side

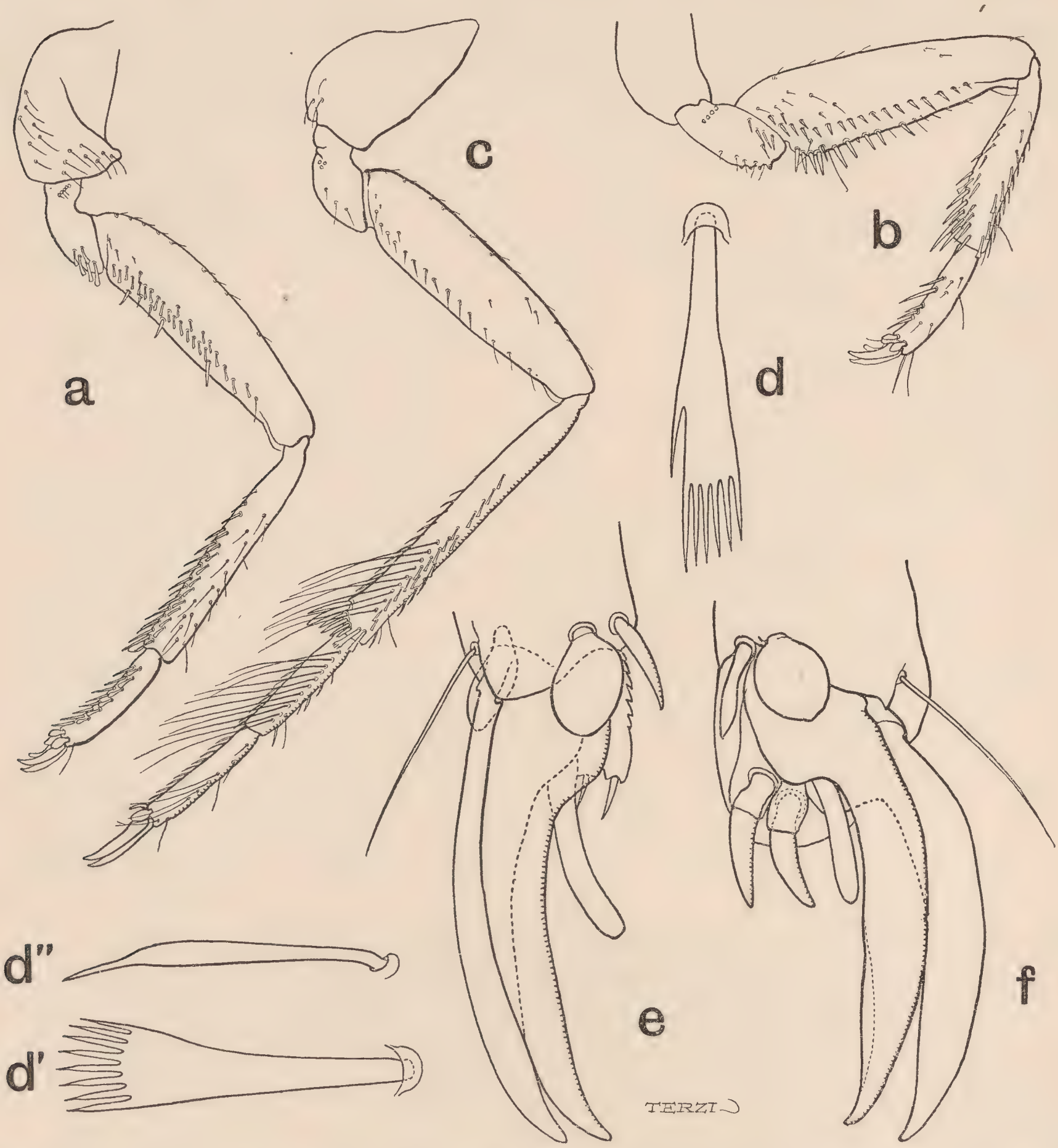

FIG. 5.—*Idiocoris lithophilus*, Esaki and China: a. front leg; b. middle leg; c. hind leg; d. d'. comb-headed or pectinate bristles present on the legs; d''. lateral view of pectinate bristle; e. highly magnified view of tarsal claws of front leg showing arolia, pulvillus, and peculiar apical tarsal structure; f. *Paskia minutissima*, Esaki and China, apical tarsal structure of front leg showing secondary claws developed from arolia.

with a row of weak pointed spine-like bristles, and along the middle of the outer side with a row of depressed pointed bristles; tibia slightly longer than femur (16 : 15), armed with irregular rows of comb-headed bristles, and pointed spine-like bristles (the latter very strong at the apex of tibia), and along apical half, with two rows of long swimming hairs arranged at an obtuse angle with one another; tarsus long, three-quarters the length of the tibia (3 : 4), two segmented, the segments equal in length and armed with rows of comb-headed bristles and pointed spine-like bristles, and also with two rows of long fine swimming hairs,

arranged at an obtuse angle; claws half the length of one tarsal segment. Claws of all the legs provided at base with two short processes, each bearing a bristle (arolia), and with a median membranous process (pulvillus). Abdomen flat on ventral surface, moderately convex dorsally, consisting of six abdominal and three genital segments, first abdominal segment not visible externally, last abdominal and the genital segments strongly asymmetrical; ventral abdominal segments covered with dark depressed hairs longer along the posterior margin of the sixth sternite. Five visible sternites, the second abdominal sternite bears a pair of spiracles placed laterally, and in the middle is very short, almost divided with an elevated laminate process anteriorly produced between the posterior coxae; the third

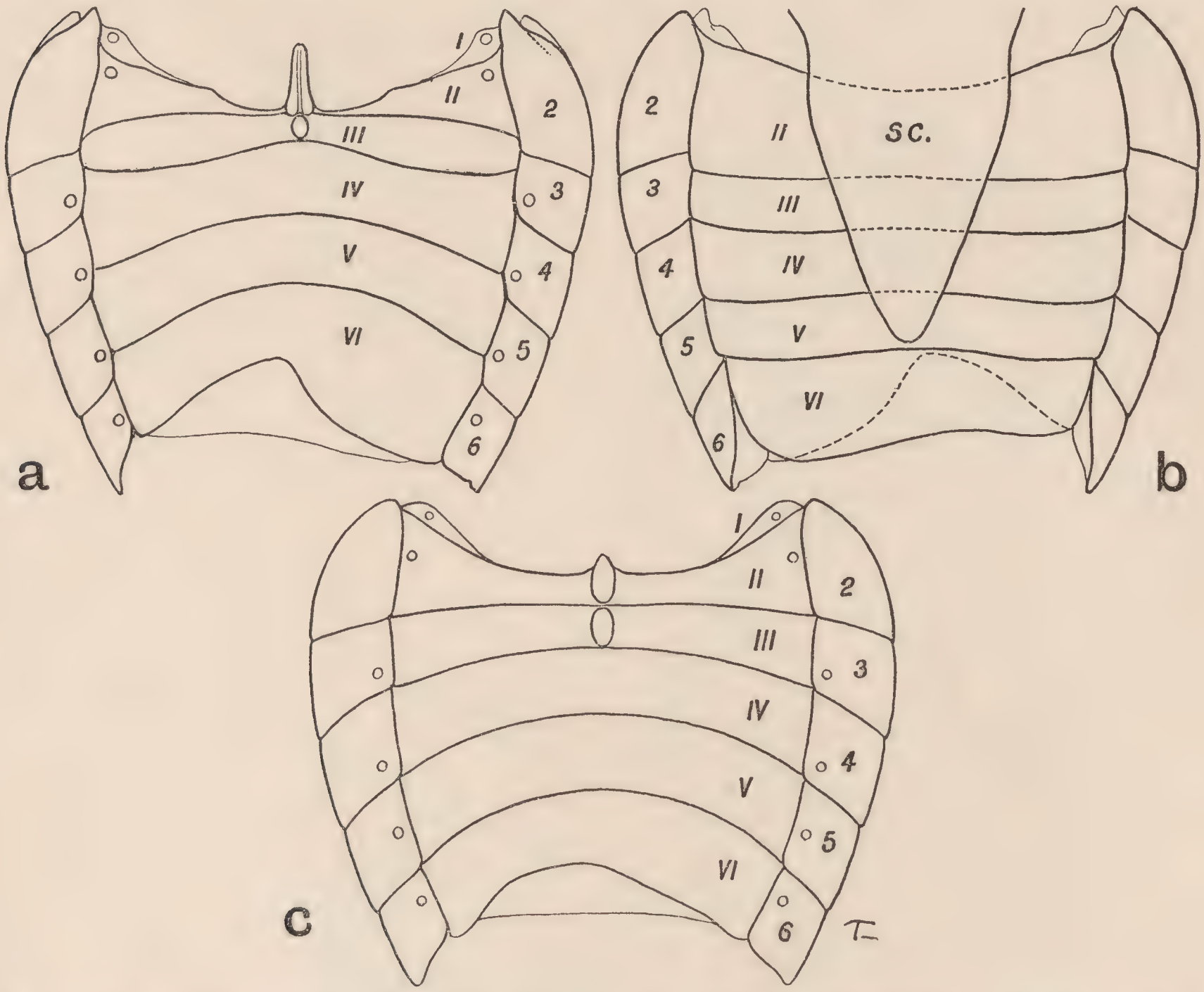

FIG. 6.—a. *Idiocoris lithophilus*, Esaki and China, male, diagrammatic ventral view of abdomen; b. dorsal view of same; c. *Paskia minutissima*, Esaki and China, male, diagrammatic ventral view of abdomen.

sternite is indistinctly separated from the second, and also bears a tubercular process in the middle. The hind margins of the second, third, fourth and fifth sternites are not continuous with the posterior margins of the corresponding pleurites, but are placed more anteriorly, and join the pleurites between their posterior and anterior margins. The sixth sternite strongly asymmetrical, the right half of its posterior margin being slightly concave, the left half strongly convex; five ventral pleurites visible, those belonging to the third, fourth, fifth and sixth sternites bearing spiracles placed close to the inner margin, and apparently opening laterally into the membrane between the pleurite and the sternite; five visible abdominal tergites, very thin and membranous, with five dorsal pleurites. The three modified genital segments strongly twisted to the left so that the normal dorsal median line lies along the left side. Seventh and eighth abdominal segments with peculiar foliate processes on the dorsal (left) side and posteriorly produced V-shaped processes of their posterior margins

on the ventral (right) side, both these processes in each segment containing a spiracle. Ninth segment (pygofer) bearing the genital armature, which consists of a long pointed right hand (ventral) paramere, a shorter, blunter, left hand (dorsal) paramere, and a rather pointed aedeagus between the parameres. The aedeagus is differentiated into three distinct regions, a long rather narrow strongly chitinised phallosoma, with an elongated oval mouth opening on the dorsal side towards the pointed apex, a membranous invaginable

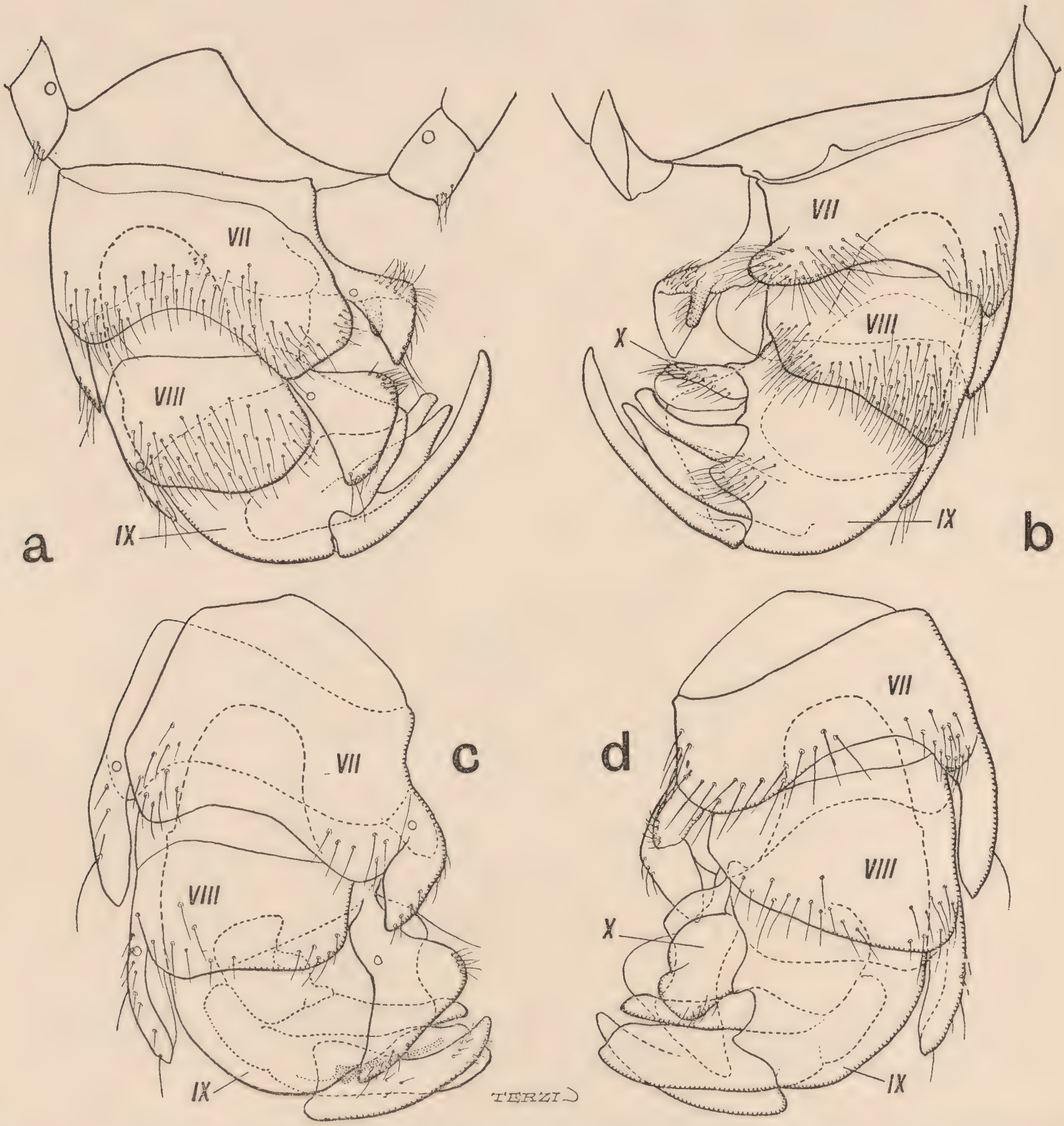

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FIG. 7.—a. *Idiocoris lithophilus*, Esaki and China, ventral view of male genital segments, showing strong left-hand asymmetry; b. dorsal view of same; c. *Paskia minutissima*, Esaki and China, ventral view of male genital segments; d. dorsal view of same.

conjunctiva without (or with very minute) appendages and a strongly chitinised vesica. The ejaculatory duct enters the genital sac, and passes below the basal plates to the aedeagus. Before entering the vesica, the duct becomes thickened, and swells out into a very small ejaculatory reservoir, whence it passes up the vesica and ends in the gonopore at the apex. The basal plates are thin, flat and expanded, and continuous with each other dorsally; they hinge on to the base of a horseshoe-shaped apodeme lying on the floor of the genital chamber. The aedeagus is hinged on to this apodeme. The tenth segment is represented by a small more or less tubular anal segment. All the segments with transverse bands of hairs. It is impossible here to describe in detail the complicated structure of the

genital segments, and reference must be made to the figures (see fig. 7). It must be remembered, however, that the figures are made from potashed specimens so that the genital segments are represented in an extended condition. In the normal condition these segments are contracted so that the long curved right-hand paramere rests with its tip curving over the left-hand side of the sixth ventral abdominal segment.

Total length, 1·54 mm.; greatest breadth across elytra, 0·92 mm.; breadth across base of pronotum, 0·85 mm.

Structure. ♀. About the same size as ♂, but distinctly stouter in shape. Differing

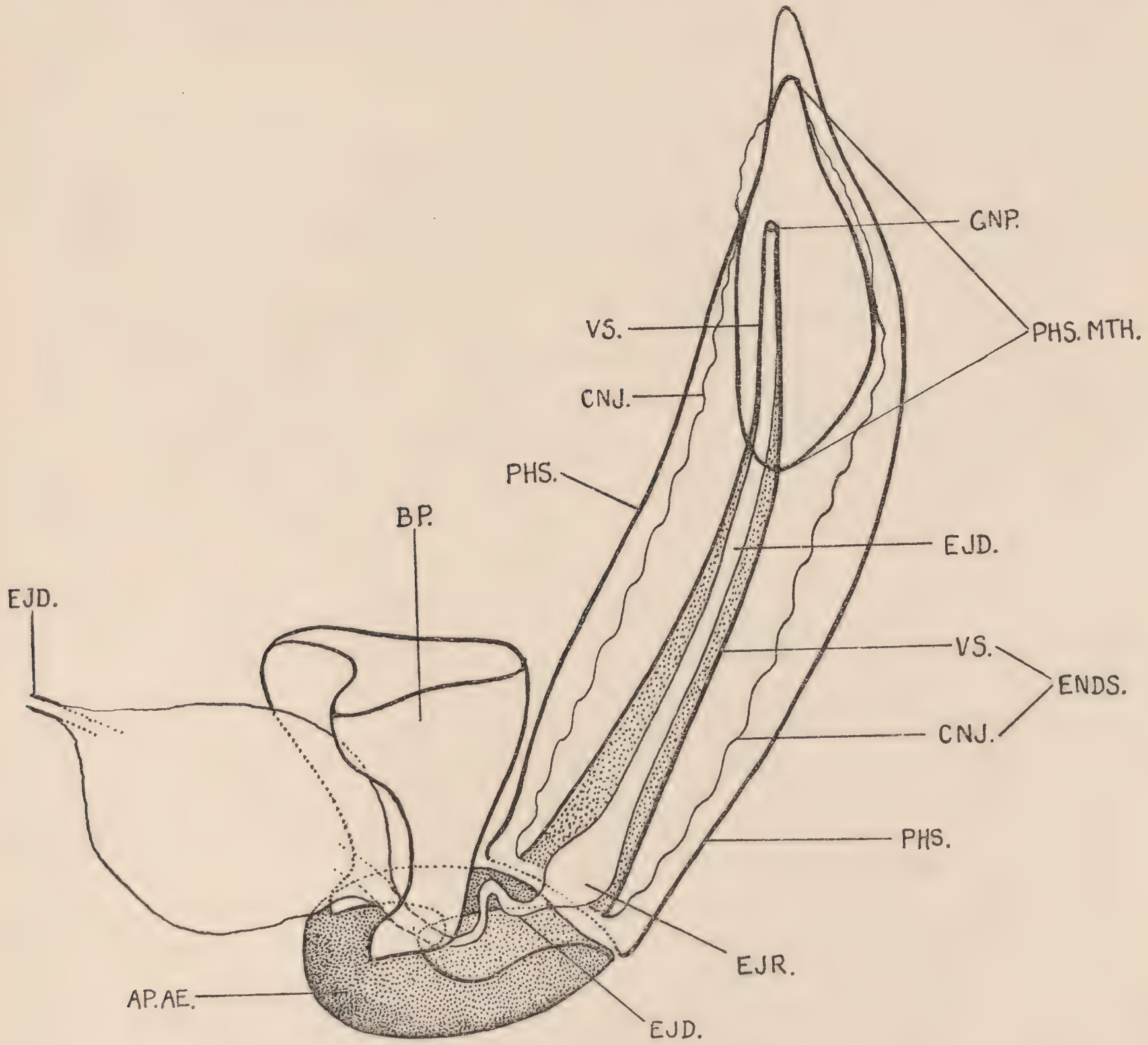

FIG. 8.—*Idiocoris lithophilus*, Esaki and China. Diagrammatic interpretation of aedeagus: AP.AE. apodeme on which aedeagus hinges; BP. basal plates; CNJ. conjunctiva; EJD. ejaculatory duct; EJR. ejaculatory reservoir; ENDS. endosoma; GNP. gonopore; PHS. phallosoma; PHS.MTH, phallosoma mouth; VS. vesica.

from the male in the following characters: the lateral constrictions of cephalonotum deeper and forming a distinct angle below the head; the right elytron with the costal margin towards the apex strongly dilated; forming a lobe-like projection bearing a number of sensory organs. This asymmetrical structure is constantly found in all the female specimens, but not in the males. The armature of the legs is slightly different from that in the male.

Abdomen flat on ventral surface, moderately convex dorsally, consisting of six abdominal and three genital segments. Abdominal segments of the same structure as those of the male, excepting the last segment. Last abdominal segment symmetrical, posterior margin of the ventral side slightly concavely sinuate. First genital segment (7th abdominal) with

tergite transverse, but with sternite posteriorly expanded into a lobe-shaped process, with its posterior margin longitudinally rather irregularly split, a little to the right of the apex, thus forming two lateral asymmetrical incomplete lobes; the pleurites on each side strongly elongated, and forming a pair of long pointed lobes projecting beyond the apex of the segment, and provided with several long hairs near the outer side of apex. Second genital segment (8th abdominal) strongly extended posteriorly on dorsal surface, covered with long hairs except the anterior area; pleurites elongated forming slender lobe-like processes; sternite divided into two equal triangular-shaped lateral lobes with a row of very long conspicuous hairs near and along the outer margin; third genital segment (9th abdominal)

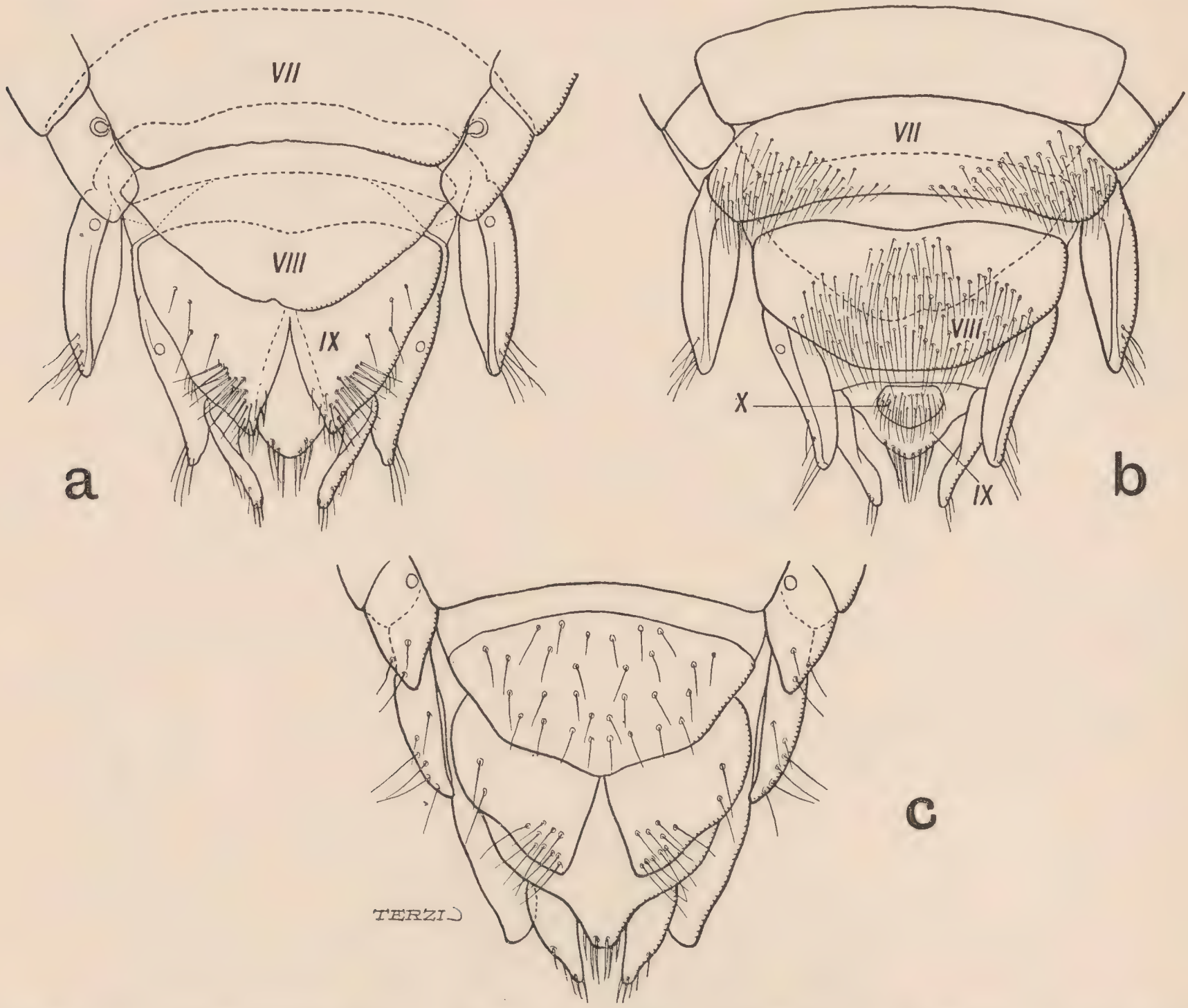

FIG. 9.—*a*. *Idiocoris lithophilus*, Esaki and China, ventral view of female genital segments; b. dorsal view of same; c. *Paskia minutissima*, Esaki and China, ventral view of female genital segments.

moderately protruded posteriorly, ventrally much rounded and furnished with long hairs at the apex; on each side with a long, very slender lobe-like process, extending much beyond the apex of the segment; dorsally with a small rounded, conical anal process representing the 10th abdominal segment.

Total length, 1·54 mm.; greatest breadth across elytra, 1·0 mm.; breadth across base of pronotum, 0·95 mm.

Larva. Presumably of last instar. A little smaller and much less convex dorsally than the imago, with the lateral margins of the cephalonotum not at all constricted, otherwise similar in structure. Dorsal surface dark brown, the entire posterior half of the cephalonotum, behind the eyes, two lateral areas in front of eyes, middle of mesonotum and the lateral marginal area of mesonotum, metanotum and abdomen, pale yellow. Eyes black.

Head and prothorax completely fused as in imago, but the boundary between them well marked by a shallow linear ω-shaped depression between the eyes on the dorsal surface. This depression is very obscure in the imagines. Eyes, antennae and rostrum of similar structure to that in imago. Lateral margins of cephalonotum not at all constricted. Mesonotum transverse, lateral regions widely dilated posteriorly forming the front wing-pads, these pads covered with rather long depressed hairs, and extending backwards almost as far as the posterior margin of the metanotum which is also slightly dilated laterally. Legs shorter and more robust, with fewer spines and bristles than in imago; all tarsi one-jointed. Segmentation of abdomen obscure, a single (apparently unpaired) median dorsal gland opening on the posterior margin of the second tergite.

Total length, 1·32 mm.; greatest breadth across abdomen, 0·92 mm.; breadth across base of pronotum, 0·87 mm.

Habitat : East Africa, Tanganyika Territory, Kirando, on south-east shore of Lake Tanganyika.

Described from 23 ♂♂, 11 ♀♀, and 6 larvae collected by Mr. S. R. B. Pask, at end of dry season (1.xi.1926). Type in British Museum.

Paskia, gen. nov.

The second genus of the subfamily is represented by a single species of which one male and two females were found amongst the *Idiocoris* material. The essential characters are the same as those of *Idiocoris*, but *Paskia* may be distinguished by the following characters :—

The sexes different in length (male distinctly shorter). More slender in shape, especially the cephalonotum; eyes comparatively much larger and extending further both ventrally and dorsally; rostrum much shorter and stouter not extending beyond the anterior coxae. Anterior margin of cephalonotum much less prominent anteriorly, lateral margins not distinctly constricted, but more or less parallel anteriorly, then posteriorly strongly diverging from the middle; not differing in the two sexes as in *Idiocoris*. Scutellum narrower in shape. Elytra symmetrical in both sexes (except for the apical interlocking device). Legs comparatively stouter, and shorter, with the spines and bristles much fewer in number; anterior tarsus at its apex with two short stout crescent-shaped claws, arising from a common basal structure which is not serrated, and facing the much longer ordinary claws. These additional claws represent the arolia which are bristle-like in the middle and hind legs, as they are in all the legs of *Idiocoris*. Second abdominal sternite wide in the middle with the median elevated process short and not projecting between the hind coxae; third sternite as wide in the middle as the second with the median conical tubercle more prominent than in *Idiocoris*. Posterior margins of sternites continuous with those of the corresponding pleurites (see fig. 6). Posterior margin of sixth sternite in the male entirely concave, only feebly asymmetrical.

Type : *Paskia minutissima,* sp. nov.

This genus is dedicated to the collector of these curious insects, Mr. S. R. B. Pask, of Christ's College, Cambridge, to whom the authors are very much indebted.

Paskia minutissima, sp. nov.

Colour. ♂, ♀. Pale sordid yellow with greyish-brown markings. Cephalonotum pale sordid yellow, posteriorly with a dark brown marginal band; eyes black; rostrum sordid yellow. Scutellum dark brown with basal margin, and extreme apex pale. Elytra opaque

brownish-grey, scattered with small irregular coarse shining dark brown spots. Sternum, venter and legs pale sordid yellow.

Structure. ♂, ♀. The chief structural characters have been given in the generic description. Surface of eyes more convex than in *Idiocoris lithophilus*; about 58 very large facets in each eye, 12 of which extend ventrally; distance between the eyes less than three times the breadth of one eye viewed from above (3 : 8). Anterior part of cephalonotum (head) sparsely covered with long, pale hairs; semi-circular linear impression more shallow, and situated more closely to the posterior margin than in *Idiocoris lithophilus*; antennal setae much longer. Elytra rather pointed at the apices. Anterior legs : tibia much shorter than femur (19 : 26), tarsus about half the length of tibia (10 : 19); armature much reduced, no comb-headed bristles, the underside of femur armed with two rows of irregular spines; tarsi with claw-like arolia, structure shown in figures. Intermediate legs : femur with two rows of spine-like bristles on the underside, the posterior row consisting of four moderately robust spines near base, and one or two additional shorter spines towards the middle; claws with arolia unlike those of the anterior legs, but resembling those in *Idiocoris*. Posterior legs : femur slightly longer than tibia (13 : 12), tarsi more than three-quarters the length of the tibiae (7 : 8), claws as in intermediate legs.

Posterior margin of 6th abdominal sternite in male strongly concavely sinuate, the left side of the sinuation much longer than the right side. Genital segments of ♂ in general plan similar to those of *Idiocoris lithophilus*, but with the lateral (dorsal and ventral) lobes of the first and second (7th and 8th abdominal), segments different in shape, particularly the right hand (dorsal) V-shaped posteriorly directed processes, which are comparatively much shorter and less acute; ventral paramere only slightly longer than dorsal paramere, much more prominently elbowed just above the point of articulation. Dorsal paramere (left hand) rather more pointed than in *I. lithophilus*, broadest below the apex. Phallosoma very wide, much wider than in *Idiocoris*,* especially towards the apex, which is truncated and not at all pointed, with the mouth large; vesica similar to that in *I. lithophilus*; basal plates much narrower viewed laterally.

Genital segments of ♀ also similar in general structure to those of *I. lithophilus*, but differing in the comparative size and shape of the parts. The lobe-like pleurite of the first genital (7th abdominal) segment much shorter and more slender. For details, reference must be made to the figures (see fig. 9).

Total length, ♂ 1·0 mm., ♀ 1·17 mm.; greatest breadth across elytra, ♂ 0·56 mm., ♀ 0·71 mm.; breadth across base of pronotum, ♂ 0·56 mm., ♀ 0·68 mm.

Habitat : East Africa; Tanganyika Territory, Kirando, Lake Tanganyika.

Described from 1 ♂ and 2 ♀♀ collected by Mr. S. R. B. Pask, 1.xi.1926. Type in British Museum.

Ecology and Biology of the Idiocorinae.

From the zoogeographical point of view, Lake Tanganyika, lying on the boundary between Tanganyika Territory and the Belgian Congo, is of great interest. It is, in fact, one of the most remarkable lakes in the world, comparable only with the Caspian Sea and Lake Baikal in the huge number of its endemic species. It occupies part of the Great Rift Valley, and is very deep, reaching a depth of 1,435 metres. The conditions are almost oceanic, and the water temperature is uniformly high (about 26° C.). Various theories have been advanced to account for the faunal peculiarities of Lake Tanganyika

* In this respect the aedeagus resembles that in *Helotrephes*, in which, however, the phallosoma is pointed apically, the ejaculatory reservoir large, the vesica more or less spirally twisted at base, and the conjunctiva with distinct appendages.

compared with the other large African lakes. These theories are admirably discussed by Dr. W. A. Cunnington in his fauna of the African lakes.* The most probable cause of the high percentage of endemic species (73 per cent.) appears to be prolonged isolation, possibly assisted by the relatively large amount of magnesium salts in the water. Although the aquatic fauna has been so well studied, little is known of the aquatic insects. Judging, however, by the extraordinary abundance of endemic and highly specialised forms of other invertebrate life, it would seem that the lake will also provide many interesting aquatic insects. This view is thoroughly borne out by the peculiar structure of *Idiocoris* and *Paskia*.

According to Mr. S. R. B. Pask, the two species of IDIOCORINAE were collected at the end of the dry season, under small stones in the surf zone, in about two feet of water along the rocky shore at Kirando. They were found in company with larvae of various Diptera, Trichoptera and Turbellaria. Amongst the material of *Idiocoris* and *Paskia* were two Turbellarians † and a number of specimens of an Ostracod. It is possible that these insects remain submerged, and do not come to the surface for a supply of air as do other aquatic insects. The spiracles do not open externally, nor is there any very abundant thick hairy pubescence on the under surface of the body. They probably live continually on the underside of submerged stones, breathing the oxygen dissolved in the water. Only one other insect,‡ *Aphelochirus aestivalis*, F., a water-bug of the family APHELOCHIRIDAE, is known in the adult stage to breathe the oxygen dissolved in water.§ Although the hind tibiae and tarsi bear swimming hairs, these are not strongly developed as in *Notonecta* and *Corixa*, and it is possible that the insects rarely swim. The legs are chiefly ambulatory in structure, and the tiny creatures appear to spend their lives crawling over the under surface of stones. The complete reduction of the antennae may be significant of adaptation to this curious habitat. The supposition that the insects are more or less sedentary in habit is borne out by the fact that in many specimens the margins of the head and body bear several small infusoria (Suctoria ?), some of which are even attached to the surface of the eyes. From the structure of the mouth-parts it is evident that the HELOTREPHIDAE are predaceous. The front legs, however, are not adapted for catching the prey, as they are in many other water-bugs, such as BELOSTOMATIDAE, NEPIDAE and NAUCORIDAE. This fact together with the sedentary habits makes it highly probable that the IDIOCORINAE feed only on inactive animals. Indeed, among the specimens brought back by Mr. Pask, there is a larva of *Idiocoris lithophilus* killed in the act of grasping one of the previously mentioned Turbellarians, with the rostrum directed towards it, and with the mandibular and maxillary stylets projecting from the labium and touching (though not piercing) the tissue of the Platyhelminth. It is thus quite reasonable to assume that Turbellaria form at least part of the diet of the Idiocorid species.

* W. A. Cunnington, "The Fauna of the African Lakes." A Study in comparative limnology with special reference to Tanganyika (*Proc. Zool. Soc. Lond.*, 1920, pp. 507–622).

† These Turbellarians have been studied and described (*Ann. Mag. Nat. Hist.* (9) xx, pp. 380–385, figs., Oct. 1927) by Dr. H. A. Baylis, who believes them to represent a new species of PLAGIOSTOMINEA, *Plagiostomum lacustre*, Baylis. He has also observed small Ostracods in the gut of some of the worms, so that the Crustacea form part of their diet.

‡ Except the Dipteron *Pontomyia natans*, Edwards, which is found in the sea amongst plankton, and possibly also the marine bug, *Aëpophilus bonnairei*, Sign.

§ Szabó-Patay, J., Az Aphelochirus lélekzökészülékének szerkezete és müködése. (Über den Bau und Funktion des Respirationsapparates von Aphelochirus).—Állattani Közlemények, 17. köt., 1918, pp. 48–66, 94, 15 figs. In Hungarian with a résumé in German. This paper afterwards appeared in French in *Ann. Mus. Nation. Hung.*, vol. 21, pp. 33–55, 1924.

Phylogeny of the Family Helotrephidae.

Although *Helotrephes*, *Idiocoris*, and *Paskia* are undoubtedly Heteropterous genera, they cannot be referred to any of the known families of the suborder. It is, however, quite certain that they form part of that great group of water-bugs, the Hydrocorisa. It must be explained here that the Hydrocorisa, as regarded by the present writers, differs from the Hydrobiotica of Reuter in the exclusion of the Gerroideae, which are believed to be of distinct origin. The phylogeny of the Hydrocorisa, as here understood, may be expressed by the accompanying phylogenetical tree. The first group to be split off from the ancestral Hydrocorisid type was undoubtedly the Sandaliorrhyncha (Corixidae), in which the mouth-parts have become highly specialised as an adaptation to phytophagous habits. Soon after the separation of the Corixidae, another group became separated, which may be regarded as the

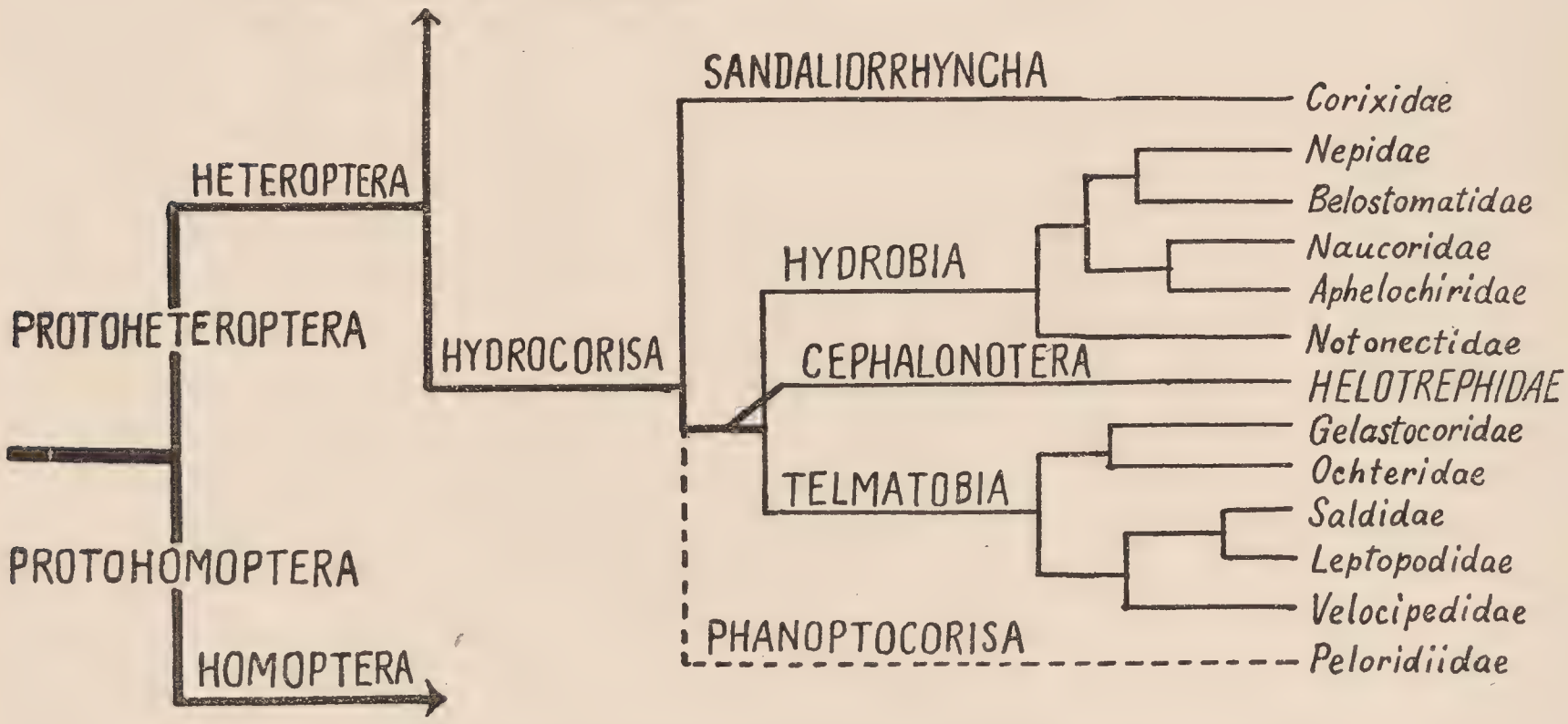

Fig. 10.—Phylogenetical relationships of the Helotrephidae.

prototype from which the present Helotrephidae have evolved. This ancient group probably consisted of littoral forms, possessing a combination of the fundamental characters of the modern Notonectoideae and Ochteroideae. The remaining Hydrocorisa later formed two main divisions, the **Hydrobia** ser. nov., which became adapted for life in the water, and from which the modern Notonectoideae have evolved, and the **Telmatobia** ser. nov. which became adapted for life at the water's edge, and which have given rise to the modern Ochteroideae and Saldoideae. It is very doubtful if Reuter was correct in assigning the Peloridiidae to the Ochteroideae. So little is known of the family that it is difficult to place it in its correct position. It is probable, however, that the Peloridiid prototype became separated from the Hydrocorisa about the same time as the Sandaliorrhyncha. In any case, this family may be considered as representing a distinct series which may be called **Phanoptocorisa** ser. nov.

Systematic Position of the Family.

Although the fusion of the head capsule with the prothorax is exhibited by other arthropods, it is unique amongst the known free-living insects,* and forms

* Dr. Handlirsch has pointed out that this character is strikingly exhibited in female Strepsiptera, which, however, are permanently endoparasitic.

one of the most important distinctions of the HELOTREPHIDAE. In this case, however, it is obviously due to extreme specialisation, probably brought about by the insects' environment, and may be regarded only as a case of parallel evolution with other arthropoda. The eyes are much reduced in comparison with the size of the head, and are almost dorsal. This degeneration of the eyes may have been caused by the fact that, in the habitat adopted by the insects, the eyes would be seldom used. This tendency is exhibited, though to a much less degree, among some forms of the NAUCORIDAE. In the IDIOCORINAE the antennae are represented by a pair of peculiar sensory organs. Although microtome sections have been made, it is impossible to make out if these organs are two-segmented, as are those of the HELOTREPHINAE, the only definite structural character distinguishable being the flat, oval, disc-like organ with its surface covered with long setae, and with a peculiar circular structure of doubtful nature near the anterior margin. This reduction of the antennae may have been brought about as an adaptation to the peculiar habitat of the subfamily. The rostrum is typical of predaceous Heteroptera, but the labrum, which is usually very well developed in other water-bugs, especially in the NAUCORIDAE, is entirely absent. The scutellum is more strongly developed than in any other group of the Heteroptera, except the Pentatomoideae. The pro- and mesosternal carinae and the anteriorly directed prolongation of the second abdominal sternite are also characteristic of the Pentatomoideae, in which, however, the metasternum and not the prosternum is carinated.

The structure of the elytra and wings is not of much value in deciding the relationships, since they are obviously of special adaptive character. In *Helotrephes* the hind-wings are usually absent in which case the clavus is fused with the corium, but in some species there is a winged form, in which the elytra have the clavus separated from the corium. The legs are little specialised, and probably retain some of the primitive characters. The front legs are not at all adapted for grasping the prey, and this character is probably typical of the ancestral Hydrocorisa, since it occurs in both the Hydrobia and Telmatobia. The strongly adapted predatory front legs have been independently evolved later in both these groups. The number of tarsal segments, 1–1–2, is different from that in all the other families of the Heteroptera, and is also, probably, a primitive character. Although the legs are not modified, the armature is specialised in several respects. The front and middle legs resemble those of the OCHTERIDAE in the arrangement of the spines; the hind legs possess two rows of long hairs which are evidently a slight adaptation for swimming. In the IDIOCORINAE the legs bear comb-headed bristles, which are probably used in cleaning the insect and ridding it of undesirable Suctoria, or other epiphytes. The well-developed claw-like arolia of the front legs of *Paskia minutissima* are possibly an adaptation for grasping the prey. The structure of the genitalia, especially the aedeagus in *Idiocoris*, is similar to that in the CORIXIDAE as figured and described by Pruthi. The vesica is, however, much shorter and more strongly chitinised, and there appears to be a distinct ejaculatory reservoir. There is also a chitinous horseshoe-shaped apodeme lying on the floor of the genital chamber below the basal plates. Summing up, nearly all the characters are specialisations for some peculiar life below water (although the biology of *Helotrephes* is unknown), and there is nothing except, perhaps, the structure of the aedeagus, to denote relationship to any of the modern families of the Heteroptera. It is, therefore, reasonable to suppose that the HELOTREPHIDAE are very specialised forms of an ancient group of insects, the prototype of the Hydrocorisa.

AN ERROR OF METAMORPHOSIS, HYSTEROTELY, IN A LEPIDOPTEROUS PUPA, WITH A DISCUSSION ON PROTHETELY AND HYSTEROTELY

By E. A. Cockayne, D.M., F.R.C.P.

[Read October 5th, 1927.]

With one Text-figure.

Mr. K. G. Blair kindly handed over the pupa to me for description and at the same time gave me the figures and his notes, which I have drawn upon very largely and for which I am greatly indebted to him. He found it amongst cobweb and rubbish, apparently without a cocoon, under the bark of a fallen birch trunk on Stanmore Common, Middlesex, on April 11th, 1925.

It is 7 mm. long; the greater part is honey-yellow in colour, but the ventral part of the thorax and of the first four abdominal somites and considerable portions of the legs, which in a normal pupa would be covered by the sheaths of the wings and legs, are white and membranous. The head is free, not much deflexed, with a group of six ocelli on each side. The antennae are free and project upwards and forwards; they are many-jointed and towards the apex each is bent sharply in a ventral direction. The labrum is transverse and emarginate; the mandibles are stout and hard, each having four sharp teeth at the apex; underneath them is a pair of large thick organs with rounded apices apparently representing the maxillae or their palpi. The thoracic somites are all distinct, the mesonotum being much longer and wider than either the pronotum or the metanotum, but without trace of wings. The legs are flexed like normal pupal legs, but are lying more loosely and are much shorter than normal, the third pair not projecting beyond the second abdominal somite. The coxae of the prothoracic legs and the tibiae of all three pairs are armed with narrow strips of hard yellow chitin and the remaining parts are white and membranous. The parts protected by thicker chitin are those, that in a normal pupa would have been on the surface. The tibiae of the mesothoracic legs are longer than those of the others and have a larger chitinous plate, but unlike the others they have no tarsi. The vertical diameter of the thoracic and first two abdominal somites is much less than that of the succeeding somites, that of the third abdominal somite gradually increases posteriorly. The space thus left would have been occupied by the wings in a normal pupa. The heavily chitinised part of the fourth abdominal somite covers only about half the sides anteriorly, but runs obliquely downwards and reaches the ventral surface posteriorly, and so a space is left in front to accommodate the tips of the wings, if they had been present. The fifth and sixth abdominal somites, the first that are completely chitinised, have each a pair of ventral tubercles representing the third and fourth pairs of larval prolegs. The last three somites are more or less shrouded by the adherent and shrivelled remains of the larval skin. This is hairy with normal-looking thoracic legs and hooked prolegs on the third to the sixth and on the ninth abdominal somites. The pupal spiracles are white, and the setae, foreshortened in the drawing, are uncoloured and almost as long as those of the larva. The pupa was alive when found, but died soon afterwards.

The pupa is that of a Microlepidopteron, its general aspect suggests that it is that of a Tineid, but a more exact identification is impossible. The head shows both larval and pupal characters. The antennae are pupal, though not as fully developed as in a normal pupa. The position of the ocelli is different from that found in the larval skin, for the cast skin shows six ocelli, five in a semicircle facing anteriorly and the sixth lying alone posteriorly. The jaws are longer and narrower than those of the larval head and more sharply toothed. The larval jaws are incorrectly drawn in the figure of the whole pupa, but their

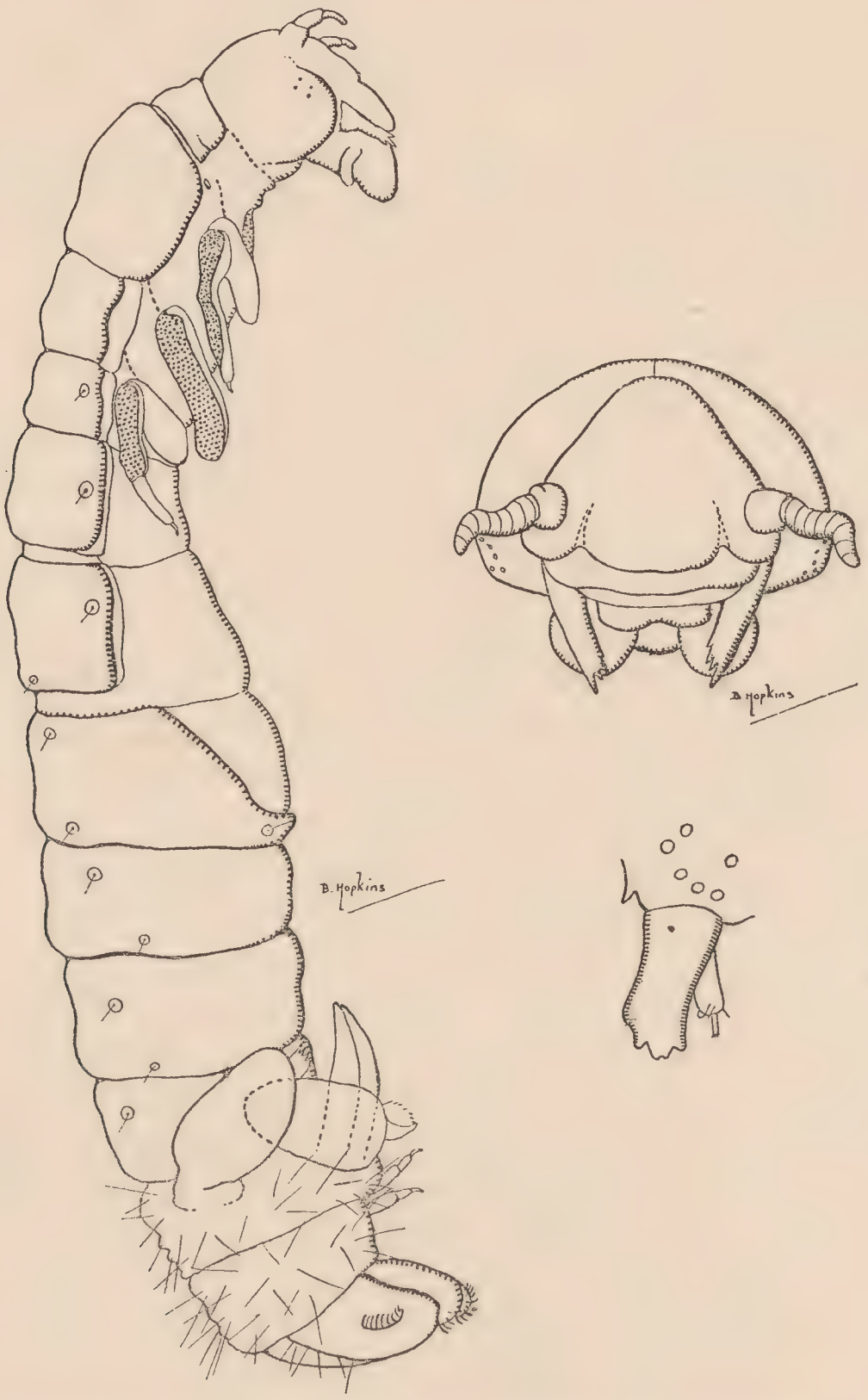

FIG. 1.—*Lepidopterous Pupa.* Lateral aspect showing Hysterotely; anterior aspect of head on larger scale; lateral aspect of mandible of larva more highly magnified.

true shape is shown in the large-scale drawing. The pupal jaws recall those of some Neuropterous or Trichopterous pupae, but show no evidence of possible mobility. Projecting jaws are found in some primitive Lepidoptera such as the ERIOCRANIIDAE, but they are completely divergent, and the larva is a leaf-miner. This hairy larva with well-developed legs and prolegs must have been an external feeder, and the jaws of its pupa must be regarded as a persistent larval character. The large-scale drawings show the great difference in the maxillary palpi of the larva and pupa, those of the latter being abnormal but pupal. The legs of the pupa, though very incompletely developed, are pupal and not larval. The absence of wings is a larval character, but the shape of

the thorax and anterior part of the abdomen, and the arrangement of the chitin, are adapted for their reception and are clearly pupal. Some profound disturbance of metamorphosis must have occurred and has resulted in the production of a creature more larval than pupal in some characters, and more pupal than larval in others.

When one considers how great and how rapid are the changes which take place when a larva becomes a pupa or a pupa an imago, it is remarkable how seldom any error of development occurs. I have been able to find very few cases described and none quite like this. Those which have been described fall into two groups. In the first, prothetely, structures proper to a later stage appear in an earlier one, and in the second, hysterotely, structures proper to an earlier stage appear in a later one. In both cases the abnormal structures are usually incompletely formed or intermediate in character.

Prothetely.

Larvae with wings have been met with a number of times in Coleoptera. They have been recorded in *Tenebrio molitor*, L. (Tenebrionidae), by Heymons, Arendsen Hein, and Singh-Pruthi, in *Photuris pennsylvanica*, de Geer. (Lampyridae), by Williams, in *Lopheros fraternus*, Rand. (Lampyridae), by Barber, in six larvae of *Anthrenus varius*, F. (Dermestidae), by Busck, in *Telmatophilus typhae*, Fall. (Clavicornia, Cryptophagidae), by Kemner, in *Malthodes* sp., ? *batillifer*, Bourg. (Cantharidae), by Peyerimhoff, in *Cantharis* (Cantharidae), by Trägårdh, in *Dendroides canadensis*, Latr. (Pyrochroidae), by Riley, and in *Donacia* (Chrysomelidae), by Böving. In addition to the external wing-pads these larvae had other abnormalities. In the larva of *Dendroides* there were compound eyes and other pupal characters. The *Malthodes* described and figured by Peyerimhoff differed in several respects from a normal larva; the abdomen was shorter, the eyes larger and situated further back, and the antennae were differently formed. In the *Donacia* larva the posterior part of the body was like that of a nymph, without caudal spines, though the anterior end was like that of a larva except for two large pupal wings on one side of the thorax. All the *Tenebrio* larvae had several other pupal characters.

In Lepidoptera the condition is much rarer. Jones describes and figures a larva of *Melanippe montanata*, Schiff., one of twelve, which grew much faster than the rest and in its last instar had imaginal legs and pectinated antennae. The latter were of gelatinous consistency and, as they began to shrivel and the larva appeared to be moribund, it was killed and preserved. Lindner figures and describes a larva of a cross between *Lymantria dispar*, L., and its Japanese form, *japonica*, Motsch., with antennae resembling those of a pupa. Harrison describes a larva of the hybrid *Oporinia* (*Oporabia*) *dilutata*, Schiff. ♂ × *O. autumnata*, Bork. ♀. It was one of a brood, fourteen of which in their penultimate instar, instead of moulting normally, spun silken pads and remained motionless for a fortnight. Thirteen died owing to interference by other larvae caged with them, but the fourteenth, which had been isolated, moulted after five weeks and then showed imaginal characters. It had a very small head with many-jointed antennae, eyes with both imaginal and larval characters, and four rudimentary wings with vestiges of imaginal neuration, one 3 mm. long and three 1·75 mm. long. The legs approached those of an imago in structure. Winneguth records six abnormal larvae of *Dendrolimus pini*, L. One pupated and a small normal male emerged. These larvae had imaginal characters in the antennae, maxillae, and legs, of which Kolbe gives a full

description with illustrations. Cesare Majoli in 1813 had some larvae of *Bombyx mori*, L., which developed imaginal characters after the fourth ecdysis. The head was small, furnished with small black faceted eyes placed close together and grey antennae. The thorax was narrow and its third somite like that of the third ring of a larva; there were two pairs of wings, grey in colour, the first pair long and narrow and the second shorter and still narrower. The abdomen was like that of a larva in form and in number of somites. Hagen gives a long account of them and a short description appeared in our *Transactions* for the year 1879. In the same year an imago of *Orgyia* (? *antiqua*, L.), stated on the authority of H. S. B. Gates to have come out of the larval skin without having passed through the pupal stage, was shown by J. Jenner Weir. This must have been a larva with imaginal characters like Majoli's silkworms.

Hysterotely.

This term has been applied to cases in which the larval head has been retained in the pupa or imago, but this is merely due to an incomplete moult. If used at all it should be reserved for the true errors of metamorphosis, in which larval characters appear in the pupa or imago or pupal characters appear in the imago. Strickland used the word metathetely for the same phenomenon, but hysterotely has the prior claim. Examples of this abnormality form a more heterogeneous group than those collected under prothetely.

In Coleoptera Bertrand mentions a nymph of *Cionus scrophulariae*, L. (Rhynchophora, Curculionidae), with the head and thorax larval and the wings abnormal. Chapman's *Tribolium confusum* larvae discussed later were really pupae with larval characters, and it is quite likely that Barber's *Lopheros* and Böving's *Donacia*, which was found in a cocoon, were the same.

In Lepidoptera Goss exhibited the pupa of a *Tortrix* with larval legs. Sharp, under the title "Arrested development of parts in insects," gives an account of a larva of *Depressaria heracliana*, de Geer. When found nearly full grown there were three eggs of a parasite on the head and one on the thorax; the former were dead, but the latter sank into a pit and had moisture round it. A few days later the abdomen had become pupal but the head and thorax were still larval. Discussing it he says: "Some time ago I published a note showing that, in a case I had observed, an abnormal combination of this kind occurred as the result of injury, before metamorphosis, to the part that remained in the larval state." I have been unable to trace this earlier reference. Chapman by feeding larvae of *Triphaena comes*, Hb., on arbutus, an unsuitable food, obtained a larva, which instead of pupating continued as a larva for a further instar, grew to a great size and then died. The species is usually constant in the number of its instars, and had a critical examination been made pupal characters might have been found. He repeated the experiment and some larvae reached full-growth and prepared for a further ecdysis. Most of them failed to cast their skins, and those that succeeded refused to feed. All of them showed some pupal characters in the antennae, maxillae, eyes and legs. They were in reality pupae with larval characters. Powell records a parallel case in *Papilio alexanor*, Esp. One larva passed into a sixth instar instead of pupating. The head and legs were very large and the mouth-parts abnormal. It fed with difficulty, was clumsy in its movements, and finally died.

Clément describes and figures a pupa of *Mimas* (*Smerinthus*) *tiliae*, L., taken at Issy-les-Molineaux in 1896. It had a well-developed caudal horn on the twelfth somite, and the image bred from it had a long bristle-like

process in the same situation. He also mentions a larva of *Deilephila euphorbiae*, L., with a similar caudal horn, but there was no trace of it in the imago.

Müller gives figures and a long description of a moth, which he regarded as a new species, but which was evidently an abnormal *Psilura monacha*, L. It was found at rest on a plant of *Epilobium montanum* on June 28th, 1762. There was a triangular brownish area on the front of the head, which was transparent, and through which he could see clear liquid in continual movement. The head differed slightly in other respects from a normal larval head, and the mouth-parts were movable. It laid a number of infertile eggs and died on August 6th.

Chapman describes and figures a pupa of *Hastula hyerana*, Mill., with jaws of larval pattern, but with a rough surface instead of the polished surface of the normal larval jaws. This specimen, now in the teratological collection of the British Museum, though not nearly so abnormal comes nearer to Mr. Blair's than any other.

Several theories have been advanced to account for these errors of metamorphosis, but most of them apply only to prothetely. It has been suggested that this is a reversion on the part of a holometabolous insect towards the ancestral hemimetabolous condition. Von Lengerken considers that it represents a praenymphal stage such as occurs in *Lebia scapularis*, Fourc., and is an imperfect hypermetamorphosis. Looked at from another point of view the praenymphal stage of *Lebia* might be regarded as a normal and perfected form of prothetely. Bauer thinks that mechanical injury may bring about accelerated development of the imaginal discs. Schindler carries this a little further and says that all larvae with a heavily chitinised exo-skeleton have a special capacity for regeneration. This might apply to *Tenebrio* and other beetles, but not to Lepidopterous larvae with their thin soft skins. Dewitz is responsible for a very elaborate theory. He thinks that an oxydase, produced gradually during development, causes the change of a larva into a pupa, and that there is a specific oxydase for every set of organs; if a particular oxydase is produced in too great quantity, the organs it stimulates, antennae or wings, for example, develop prematurely. He has brought forward evidence that an oxydase causes darkening and hardening of the chitin, and that its action can be inhibited by acetic acid or strong salt solution. By injecting either of these substances into larvae of *Pieris brassicae*, L., he obtained larvae which failed to pupate, but reached an intermediate condition between larva and pupa. They were soft and cylindrical at the hinder end. It is very doubtful if they can be considered comparable with the errors of metamorphosis under discussion. He does not prove the existence of any other oxydases, and, even if they do exist, he does not explain what causes their excessive or insufficient production.

Strickland found that in larvae of *Simulium* (Diptera) parasitised by *Mermis* the histoblasts of the pupal respiratory tufts and the imaginal discs of the legs and wings were very minute, though the growth of other parts was normal, and he thinks that a special toxin prevented their growth, because another internal parasite, which stunted the whole larva, had no more effect on the imaginal discs than on any other organs. The larvae were unable to develop further because the respiratory tufts were functionless. In ants, too, *Mermis* seems to have a specific action on the imaginal discs of the wings as Crawley, Baylis, Wheeler, and others have shown.

Strickland accepts the enzyme theory and thinks there are larval and imaginal enzymes sufficiently different for conditions which cause a retarded or accelerated output of the one not to affect that of the other. But if the enzyme theory be true, there must be several enzymes, one for each set of imaginal organs, as Dewitz postulates, to account for the various forms prothetely and hysterotely take.

Bataillon thinks that the accumulation of carbon dioxide in the tissues determines metamorphosis, and on this hypothesis an abnormal alteration in its concentration would cause these disorders of metamorphosis.

Singh-Pruthi has done the most careful work on prothetely. Following up the observation of Arendsen Hein that larvae of *Tenebrio* with wings are found in almost every large culture, but that only the larvae unduly slow in growing are affected, he experimented with this species. Subjecting them to high and low temperatures he found they grew very slowly, became inert, and developed various abnormal characters. Wing outgrowths, representing part but never the whole of the pupal wings, appeared not only in the last instar but sometimes in earlier ones. The antennae were 5-jointed instead of 3-jointed as in a larva or 11-jointed as in a pupa. The abdomen was shorter than normal and in some cases had the aedaeagus and other parts of the external genitalia and even the testes fairly well developed, though not so advanced as in a pupa. Some had rudimentary compound eyes. Most of them had great difficulty in moulting and sometimes part of the skin was retained giving them the appearance of having a pupal head and thorax and a larval abdomen. A few produced pupae with abnormal wings, and the imagines, which were formed, were seldom able to get free and were abnormal also. Observing that these pupal structures developed at the same date as the corresponding normal ones in the untreated larvae, which had pupated, he considers that far from being a precocious development it is a retardation of metamorphosis, and that prothetely is a misnomer for the phenomenon. The word means that development runs in front, and, though growth as a whole may be slow, the development of some structures does take place in too early an instar. The word expresses this fact quite well. Singh-Pruthi thinks that slowness of growth with retarded development is the real cause of the condition. Retarded development has been noticed in other cases. Harrison's *Oporinia* larvae showed a most unusual pause in development, especially remarkable in larvae belonging to a genus in which growth is usually very quick. Kolbe's *Dendrolimus* larvae were most likely belated members of the first generation and not members of the second generation as he thought. On the other hand, Jones's *Melanippe* larva grew with unusual rapidity, and this explanation cannot be applied to it. Apart from this he does not explain why the delay in growth retards some structures and permits others to progress normally. It seems probable that the slow growth in some of these larvae is merely associated with the structural abnormalities and not a cause of them.

The theories put forward to account for hysterotely are equally unsatisfactory. In the case of his *heracliana* larva Sharp was of opinion that local injury was responsible, the injured part dying and not completing its metamorphosis though the other parts did so. The explanation cannot be applied to other cases. In them the delayed parts were not dead nor were they merely delayed; in some they were intermediate between larval and pupal structures or imaginal structures. In view of Chapman's work it seems probable that a toxin derived from the parasite was the cause. The parts nearest to the parasite were those affected.

R. Chapman has done some very interesting experiments on *Tribolium confusum*, Duv. (Tenebrionidae), which in some respects are more illuminating than those of Singh-Pruthi on *Tenebrio*. The imagines of *Tribolium* when disturbed emit a very irritating gas smelling of aldehyde. Larvae in their last instar were kept exposed to this gas, and when they moulted, instead of producing pupae, ten per cent. of them produced abnormal larvae. These had wing-pads; some had larval, some pupal mouth-parts, and one had no mouth-parts at all; some had larval legs on one side and pupal legs on the other; in one the mesothorax was absent on one side and the prothoracic and mesothoracic legs arose close together. Only one abnormal larva moulted again after a length of time equal to the normal pupal period, but was still in the same state of incomplete development. The rest died. No abnormal larvae were found among nine or ten thousand controls. When pupae were exposed to the gas, the imagines often had reduced or absent parts.

Chapman explains his results by saying that a small dose of gas inhibits the development of a part and a larger dose kills it altogether. Asymmetrical examples are due to gas entering the spiracles of one side only, and the specimen in which a mesothoracic leg developed in spite of the absence of the mesothorax is explained by the fact that this leg receives its air by a branch from the trachea supplying the prothoracic leg.

Prothetely and hysterotely appear to be very closely related phenomena and an explanation only applicable to one of them cannot be accepted. For this reason they cannot be atavistic. Larvae with wings and pupae without them cannot both be reversions to an ancestral condition. Any explanation must also take into account the fact that on several occasions a number of abnormal insects have been found in a single family. It is most unlikely that mechanical injuries could damage even the imaginal wing-discs in several members of a brood. The development of wings, however, is not the only peculiarity in some of these insects; their abnormalities are multiple and symmetrical. It is incredible that all these parts could have been injured.

Almost every example of these errors of metamorphosis has been produced in artificial and presumably unfavourable surroundings. One of the rare exceptions is the pupa described in this paper. Heat seems to have been a determining factor in several cases. Majoli's silkworms and Singh-Pruthi's *Tenebrio* larvae were exposed to great heat. Barber's *Lopheros* larvae were kept in a hot room and several were abnormal. The *Photuris* larvae were kept in a warm room and two out of a hundred were abnormal. Cold was a factor in the case of some *Tenebrio* larvae. Arendsen Hein's *Tenebrio* larvae appeared in old cultures. Böving's *Donacia* larva is said to have been bred in an unfavourable environment, but I can find no reference to this in the English translation of his paper. Chapman's *Tribolium* larvae were exposed to an irritating gas. Sharp's *heracliana* larva was parasitised. The abnormal larvae of *comes* reared by T. A. Chapman on two separate occasions were fed on arbutus. At first sight the agents at work seem to be too varied to admit of any simple explanation. A poisonous gas was, however, the direct cause in *Tribolium*, and poisons may have been the cause in the other cases. A toxin secreted by the parasite, comparable with that of *Mermis*, may have checked the thoracic development of the *heracliana*. Arbutus, though a natural food for some Lepidopterous larvae, may contain a substance poisonous to *comes*. Heat and cold may alter metabolism and cause the formation of toxins. On the other hand their action may be a direct one, though this seems unlikely, because so many larvae are subjected to heat without any such result. There is, however,

the further possibility that heat causes the formation of poisonous substances in the food itself.

Even if it be admitted that a poison is the cause in every case, we have to explain why certain organs are affected and others unaffected, and why the effect is one of stimulation or of both stimulation and inhibition in prothetely, and of inhibition alone in hysterotely.

Poisons often have a strong selective action even on fully-matured tissues and probably a still stronger one on tissues that are undergoing rapid changes. This may explain why some organs are affected while others escape. We have still to account for the fact that some are stimulated and others inhibited. Most poisons are stimulants in small doses and depressants in larger doses, but in the case of some the doses that stimulate are confined within very narrow limits, and a very small increase of the dose causes depression, whereas in the case of others the doses that stimulate vary widely, and the margin between a dose that depresses and one that is fatal is very small. This explains how the same poison may stimulate development in one case and inhibit it in another. Stimulation and inhibition occurring in the same individual may be due to different quantities of poison reaching the different parts, but there is another possible cause. The state of the various organs undergoing metamorphosis may be so dissimilar at any given moment that even the same dose of a poison may stimulate one and depress or inhibit another. This property of poisons and the fact that the tissues acted on are in various stages of being built up or broken down during metamorphosis suffice to account for any of the abnormalities met with in prothetely or hysterotely. Until we know how regular metamorphosis is brought about, we are unlikely to discover exactly how the poisons act. Dewitz's explanation may be very near the truth, and they may stimulate or inhibit the production of enzymes. We may, however, believe that poisons bring about disordered metamorphosis without accepting his view that special enzymes determine normal metamorphosis.

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THE ANCESTRY OF THE ORDER HYMENOPTERA

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With Seven Text-figures and Plate XXVI.

Of all the Orders of Insects probably the most interesting morphologically and ecologically, and certainly the most important economically, are the Hymenoptera. Consequently the working out of the line of evolution of the Order is a problem of the greatest interest and value. In this paper, an attempt is made to gather together all the evidence so far available from palaeontology and to draw conclusions from it.

Fossil Hymenoptera closely related to living forms are fairly abundant in Tertiary strata, especially Ants, Bees and Ichneumon-flies. The only conclusion we can draw from this evidence is that the Order was well established early in the Tertiary, with all the main groups well represented, much as they are to-day except for the absence of certain very highly specialised forms.

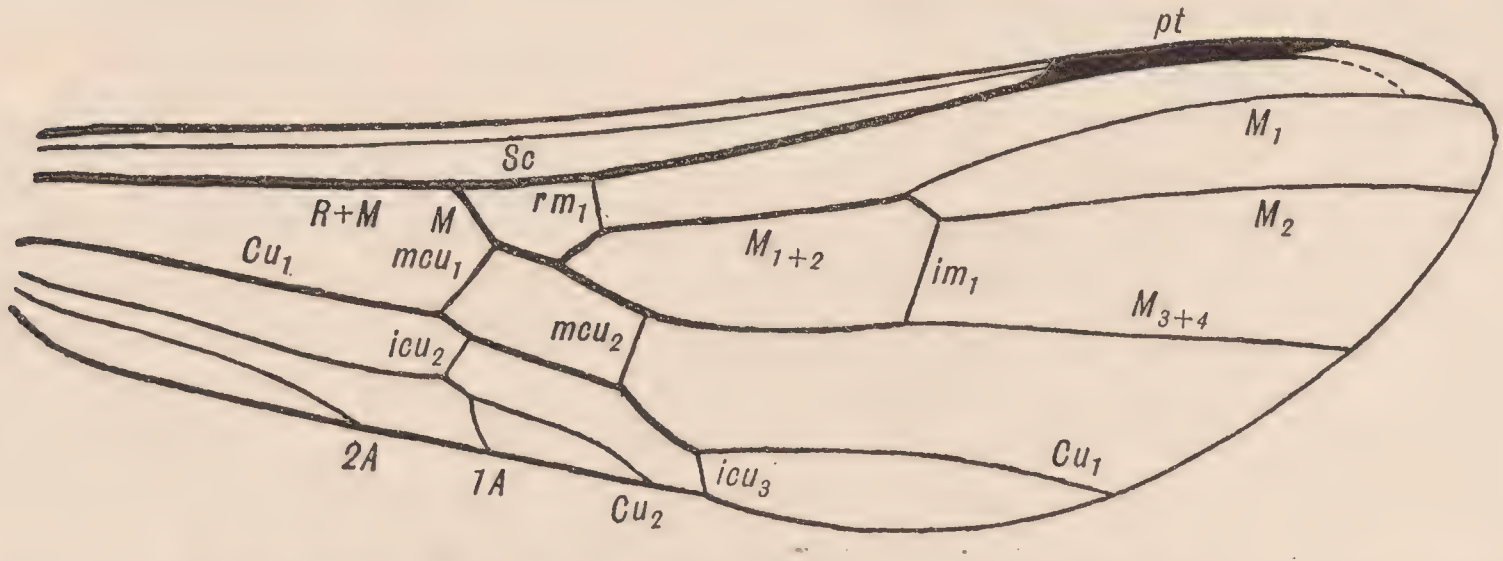
The only other true Hymenoptera known come from the Upper Jurassic. Of these, the most striking are the numerous forms of the genus *Pseudosirex*, Wey., preserved in the Solenhofen Beds of Bavaria. Handlirsch (1908) lists thirteen species, and two more are mentioned from the Lower Purbeck of Durdlestone Bay, England. There is a large number of specimens extant, mostly complete insects. I have studied a considerable number of them in the Palaeontological Museum at Munich and also in the Museum of Comparative Zoology at Cambridge, Mass. Most unfortunately, there is not a single one of these specimens in which the venation can be worked out with absolute accuracy, chiefly owing to the strong and closely parallel longitudinal ridges present on the distal half of the wing, which tend to hide the true veins, even in the best preserved specimens.

In size, the genus *Pseudosirex* ranges from a total length of 25 mm., with fore-wing 22 mm., up to a total length of 85 mm., with fore-wing 60 mm. As might be expected, all the largest specimens are females, the stiff, horny ovipositor being quite conspicuous in many of the fossils.

Bearing in mind that the Solenhofen Beds were estuarine, and that, therefore, only the larger and more strongly flying insects were preserved in it, we are struck with the relative abundance of these forest-haunting insects. In these beds, large Dragonflies outnumber all other forms in individuals; *Pseudosirex* comes next, followed by Cicada-like insects (family Palaeontinidae), large Lacewings, Locusts, etc. We can only conclude that the Pseudosiricidae must have been very abundant at that time and probably did considerable damage to the then-existing forest. And we may note, as a point of more than ordinary interest, the preservation of a single specimen of an Ichneumonoid form, *Ephialtites jurassicus*, Meun., from the Upper Jurassic of Montsech in Spain, rather poorly preserved, and with a body-length of 7·5 mm. ending in an enormously long ovipositor (about 14 mm.). Handlirsch

places this specimen in a distinct family EPHIALTITIDAE, which he considers to be intermediate between SIRICIDAE and ICHNEUMONIDAE. But, as far as I can judge from the figures, it appears to me to belong to the existing Australian family MEGALYRIDAE or Long-tailed Wasps, which are a very primitive type of ICHNEUMONOIDEA. Doubtlessly it preyed upon some primitive form of Siricoid.

In New Zealand, during the past thirty years or more, two species of *Sirex* have gained entry many times over in wood of various kinds, viz. *Sirex gigas*, L., and *Sirex juvencus*, L. The former does not appear to have become permanently established anywhere, but the latter has taken a hold of the large plantations of *Pinus radiata* (Monterey Pine, commonly called *Pinus insignis*) and is forming the habit of feeding in the sap-wood of the living trees. As a result of this habit, the size of this species appears to be increasing. It is very interesting to note that, in large specimens, the longitudinal ridging of the distal half of the fore-wing becomes very strongly marked, and the whole insect takes on very much the appearance of one of the Upper Jurassic fossil PSEUDOSIRICIDAE. Recently, Mr. W. C. Davies has taken a beautiful photograph of two



TEXT-FIG. 1.—*Pseudosirex* sp. indet., Upper Jurassic of Solenhofen (Palaeontological Museum, Munich), venation of fore-wing. Length of wing, 46 mm. New Notation (see Tillyard, 1926, p. 258).

of these insects alive on the trunk of a young *Pinus radiata*; this photograph is reproduced in Plate XXVI, and I wish to thank Mr. Davies very much for it.

In working out the venation of *Pseudosirex*, I have used three methods :—

(1) Drawing carefully, with the camera-lucida, all the venation which can be clearly made out in the fossil specimens. This gives an accurate record of the basal half of the fore-wing, but the hind-wing and the distal portion of the fore remain more or less of a puzzle.

(2) From two of the best-preserved specimens in the Munich Collection I took "rubbings." This can be done without harming such hard fossils, simply by placing a sheet of moderately thin paper over the wings and rubbing a soft, flat-pointed pencil transversely across them. It gives an accurate record of the longitudinal ridgings of the distal half of the wing and the main veins, but is not reliable for cross-veins.

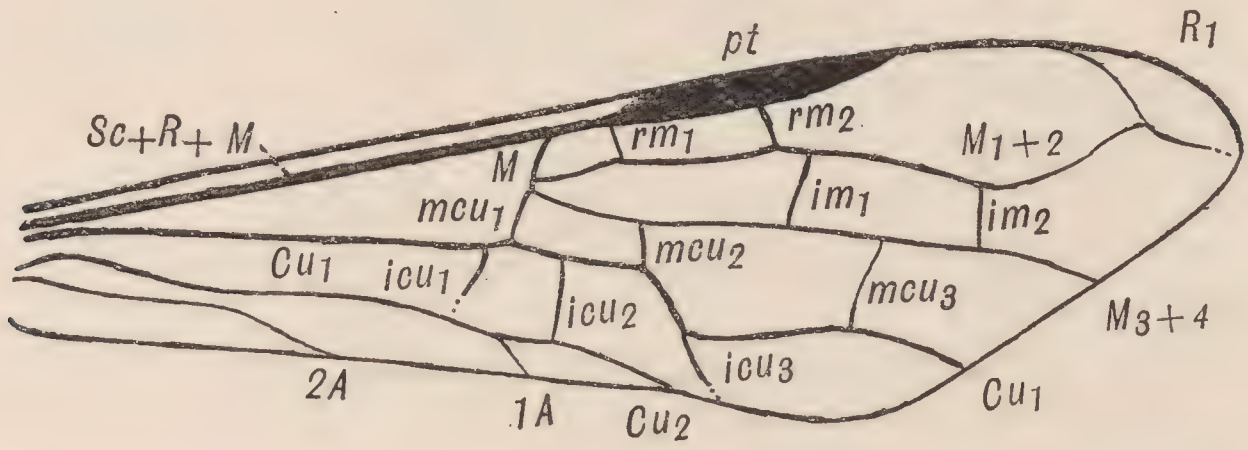
(3) Comparison of (1) and (2) with the wings as photographed in Plate XXVI, and with the actual venation of the genus *Sirex* (text-fig. 2).

The result of this study is given in text-fig. 1, in which the basal half of the wing may be taken as accurate, the distal half as only approximate. It is impossible, for instance, to determine the limits of the pterostigma, or even to say whether or not a true pterostigma existed. The vein labelled M_1 is clearly additional, in *Pseudosirex*, to the vein M_{1+2} existing in recent *Sirex* (text-fig. 2), but it is not possible to determine exactly the nature of its origin from its

common stem with M_2. There still remains a doubt in my mind as to whether this vein might not have been Rs; but I can find no connection with R, and the best specimens appear to indicate undoubtedly a three-branched M of the type shown in text-fig. 1. This would be in agreement with the XYELIDAE and other primitive forms existing to-day, and would indicate that the SIRICIDAE and XIPHYDRIIDAE have been derived from older forms having a median vein with three branches instead of two.

The points of the greatest interest and importance are (1) that the median vein came off at an acute angle to R, as in XIPHYDRIIDAE, and (2) that there was only one supporting cross-vein between R and M_{1+2}, quite close to the origin of M. Many of the fossils show this quite clearly, and there can be no doubt about it. We find the same thing in the archaic Australian *Perga*-group of Sawflies (family TENTHREDINIDAE, subfam. CIMBICINAE), where rm_1 keeps its original position very close to the basal piece of M, even though the pterostigma has become enlarged until it reaches basad almost to the origin of that vein. The conclusion forces itself upon us that the additional cross-vein rm_2, found in SIRICIDAE, XIPHYDRIIDAE and most TENTHREDINIDAE at the present day, has been added at a later date geologically, as an extra support to the steadily enlarging pterostigma.

There are, then, in the fore-wing of *Pseudosirex*, only three completely



TEXT-FIG. 2.—*Sirex* sp., recent. Venation of fore-wing. New Notation.

closed cells, apart from those which impinge either upon the base or margin of the wing; these are :—

(1) The first radial cell, *1r*, formed between basal portion of M and cross-vein rm_1.

(2) The first median cell, *1m*, formed between M_{1+2} and M_{3+4} and closed distally by cross-vein im_1.

(3) The first submedian cell, *1sm*, formed between cross-veins mcu_1 and mcu_2, with M above and Cu_1 below.

The recent discovery of some new Jurassic types of fossil Hymenoptera in Turkestan (Martynov, 1925) adds considerably to our knowledge of the early types within the Order, and is of special interest in that it shows very clearly that the type of wing exhibited by *Pseudosirex*, with only three closed cells present, is almost certainly the primitive type from which the many diverse forms of venation now existing have been derived.

The Turkestan fossils come from Jurassic slates near the village of Galkino, East Karatau. Martynov classifies them as follows :—

Family ANAXYELIDAE :—*Anaxyela gracilis*, Mart.

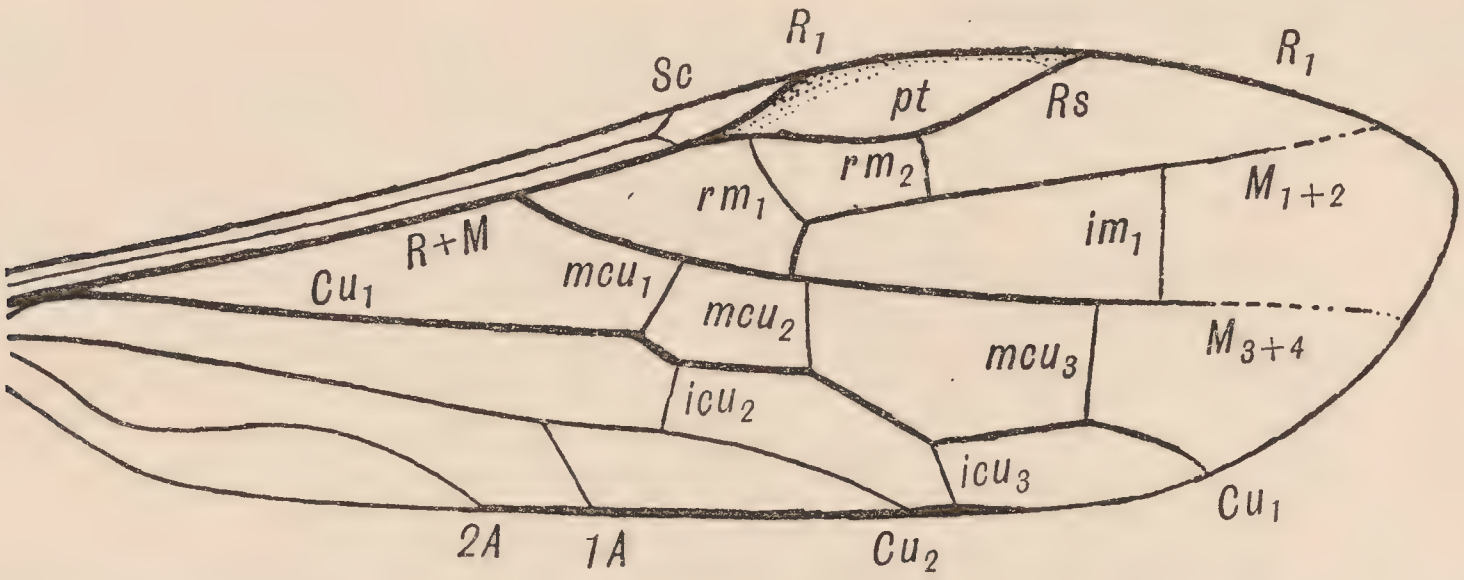
Family PARORYSSIDAE : —*Paroryssus extensus*, Mart.

Family EVANIIDAE :—*Mesaulacinus oviformis*, Mart.

Family HELORIDAE :—*Mesohelorus muchini*, Mart.

Anaxyela gracilis, Mart., is a fine fossil, almost complete, with a fore-wing 7 mm. long, and the abdomen ending in an ovipositor whose free portion is 4·6 mm. long and straight. Besides the three closed cells mentioned above for *Pseudosirex*, the fore-wing of this fossil shows an additional radial cell, *2r*, formed by the presence of a second radial cross-vein rm_2 (see also text-figs. 3, 4), and an additional submedian cell, *2sm*, formed by the presence of a third medio-cubital cross-vein, mcu_3. Thus there are five closed cells in the wing, as against six in the recent genera *Xiphydria* and *Xyela*, to both of which this new fossil appears to be allied. The form of the ovipositor indicates that the fossil did not belong properly to the Tenthredinoidea, but rather to the Siricoidea. We may accept the family Anaxyelidae as valid. It bears somewhat the same relationships to Xiphydriidae that the Pseudosiricidae do to the Siricidae, but is a little more specialised in the additional closed cells and in the complete loss of Sc.

Paroryssus extensus, Mart., is a complete insect, but not so well preserved as the previous specimen; the fore-wing is 3·4 mm. long, the body 5·7 mm. and the free portion of the ovipositor 5·3 mm. The venation appears to me to be



Text-fig. 3.—*Syntexis libocedri*, Roh., recent. Venation of fore-wing, to show structure of unchitinised pterostigma. New Notation.

intermediate between that of Oryssidae and that of Megalyridae. If we accept the family Paroryssidae as valid, we should regard it as annectent between these two recent families, and as marking definitely a passage from Chalastrogastra to Clistogastra.

Mesaulacinus oviformis, Mart., is only moderately well preserved. The venation shows only four closed cells, the additional one being the second submedian, *2sm*; the basal piece of M is strongly bent backwards, as in all Ichneumonoidea, but is not entirely aligned with mcu_1. This latter character, together with the absence of any sign of a waist in the body of the fossil, raises a doubt in my mind as to whether it is correctly placed within the family Evaniidae.

Mesohelorus muchini, Mart., is somewhat incomplete, but shows an insect about 5 mm. long, with rather elongated pterostigma and only two closed cells in the fore-wing. M comes off at right angles to R; there is a large cell *1r* between M and rm_1, the latter descending almost at right angles from the pterostigma; at mcu_2, M is strongly bent, the cross-vein itself being very short; cross-vein im_1 is incomplete, leaving cell *1m* open distally. Again, the fossil shows no sign of having a waist, and can only be provisionally assigned to the Proctotrypoidea.

One rather difficult problem, viz. the structure of the pterostigma, appears

to have been satisfactorily cleared up by the discovery and description (Rohwer, 1915) of a peculiar type intermediate between the XIPHYDRIIDAE and CEPHIDAE, *Syntexis libocedri*, Roh. (text-fig. 3). In this form, the large, swollen pterostigma of the type found in XYELIDAE (text-fig. 4) is seen to be formed by chitinisation of the cell enclosed between R_1 and Rs. In *Syntexis* this cell remains unchitinised, except to a slight extent, and consequently one can follow the courses of both R_1 and Rs with ease. R_1 forms the basal side of the cell and then runs on, fused with the costa, well beyond the distal angle of the pterostigma, almost to the apex of the wing, where it stops; Rs forms the whole of the posterior margin of the cell and fuses again with R_1 at the distal angle. Consequently the pterostigma of Hymenoptera must be regarded as not homologous with that either of Odonata or of Mecoptera; for, in the former, the chitinisation is entirely between C and R_1, while in the latter, it is chiefly between C and R_1, with a posterior extension to about half-way between R_1 and R_2. A comparison of the pterostigmata of *Syntexis* (text-fig. 3) and *Macroxyela* (text-fig. 4) will make this quite plain.

Reviewing all the above evidence, we can now construct a provisional scheme of evolution for the earlier types within the Order, as follows :—

Taking as the primitive type of fore-wing venation a type similar to that of *Pseudosirex*, with Sc distinct, basal piece of M making an acute angle with R, pterostigma incomplete, M three-branched, and only three closed cells (*1r*, *1m*, *1sm*), we can distinguish the following lines of evolution :—

(1) *Siricoid Types* :—Beginning with *Pseudosirex* itself (family PSEUDOSIRICIDAE), the next stage would be the formation of a type (not yet discovered) with five closed cells in the fore-wing, as in *Xiphydria*. True XIPHYDRIIDAE can be evolved from this type merely by the reduction of M to the two-branched condition. The extra cross-vein rm_2 must be conceived of as having arisen with the completion of the elongate pterostigma, as an extra support distally beneath it. In these forms, M retains the primitive condition of leaving R at an acute angle.

True SIRICIDAE exhibit a further character one stage in advance of this, viz. the basal piece of M is bent backwards and aligned with mcu_1 (text-fig. 2).* This specialisation takes place along every line of advance to higher types within the Order.

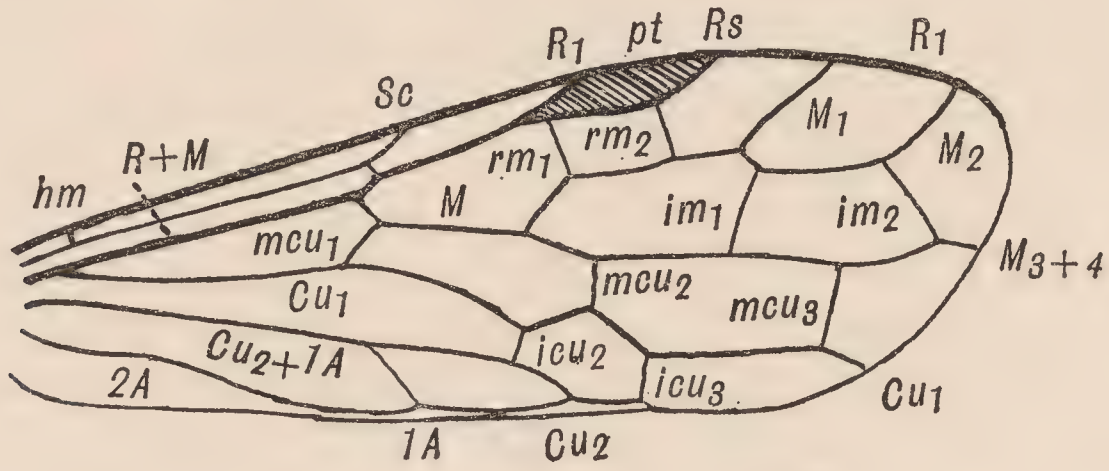
(2) *Tenthredinoid Types* :—These are specialised in having plant-feeding larvae instead of wood-borers, and there is a correlated increase in the bulkiness of the imago (the difference between Siricoids and Tenthredinoids closely parallels that between Longicorns and CHRYSOMELIDAE in the Order Coleoptera). The tendency is for the pterostigma to become enlarged and thickened, and also towards the addition of three more closed cells (*Macroxyela*, text-fig. 4), making six in all in the fore-wing. All these types must be conceived of as having arisen from the as yet undiscovered Protoxiphydriid type mentioned above, in which M keeps its original acute-angled origin from R and its three branches, and Sc remains complete. The first specialisation would be the enlargement of the space between R_1 and Rs (pterostigmatic space), preparatory to the formation of the enlarged, hardened pterostigma, with rm_2 as an extra support below it. *Ditexis* (text-fig. 3) must be regarded as a very early type, owing to the non-chitinised pterostigma and the absence of cross-vein im_2 (only five closed cells in wing), but it is specialised in having M reduced to the two-

* The fossil *Megapteritis mirabilis*, Ckll., from the Eocene of Bournemouth (*Canad. Ent.*, liii, p. 22) placed by Cockerell in PSEUDOSIRICIDAE, has the venational characters of a true Siricid.—R. J. T.

branched condition. It may be regarded as in many ways annectent between Xiphydriidae and Cephidae.

More specialised by the complete hardening of the enlarged pterostigma and by the addition of im_2 (six closed cells in the wing), but primitive in the retention of the three-branched condition of M, is the family Xyelidae (text-fig. 4). The *Perga*-group of genera may be considered as standing very close to the base of the true Tenthredinidae; the pterostigma is still only slightly thickened; there is generally a remnant of M_2 still visible, and cross-vein rm_2 is absent (only five closed cells in wing); the larva possesses no prolegs.

(3) *Oryssoid Types* :—These are specialised from the original venational type by reduction instead of addition of veins. In *Paroryssus* (Upper Jurassic) the basal portion of M_{1+2} (from its origin up to rm_1) is still complete; owing to the presence of two cross-veins rather close together distally between the two branches of M, there are altogether four closed cells in this wing; but it is important to notice that, already, rm_1 has taken on an oblique position from below the pterostigma. Thus, from forms with originally only three closed cells, but otherwise similar to *Paroryssus*, we can derive the existing Oryssidae by atrophy of the basal piece of M_{1+2}, leaving cells *1r* and *1m* fused into a single whole, and not always even completely closed distally, while cell *1sm* remains in its primitive closed form.



Text-fig. 4.—*Macroxyela* sp., recent. Venation of fore-wing. New Notation.

(4) *Ichneumonoid Types* :—In many respects the oldest of all Ichneumonoid types is the archaic Australian family Megalyridae, which can be derived almost directly from the Oryssoid type by lengthening of the ovipositor and by a very primitive formation of a rather broad waist. The venations of *Megalyra* and *Oryssus* are fairly close; the former must be conceived of as having branched off from the original Oryssoid stem well before the existing Oryssidae, as the venation is more complete, and the pterostigma not at all thickened. The Evaniidae must be even older than the Megalyridae in one respect, viz. that the more archaic genera still have cells *1r* and *1m* quite distinct; but they are specialised in other directions. These two families and the Stephanidae keep the costal space open; but in the higher families it becomes closed, so that a single stout vein, C + Sc + R + M, forms the anterior margin of the wing up to origin of M.

If this phylogeny be correct for the Ichneumonoidea, it follows that none of this group ever had cross-vein rm_2 developed. This would be in keeping with their narrow pterostigmata, which probably never required an extra support; in those forms where the pterostigma is slightly thickened, the cross-vein rm_1 had already attained such an advantageous position beneath it that no further support is needed.

(5) *Formicoid Types* :—Much has been written about the primitiveness of the Ants, particularly of the Ponerinae. It is therefore of very great interest

to note that the venation of such an archaic type as *Myrmecia* exhibits a very close similarity with *Pseudosirex*. There are, in both genera, only three closed cells; but *Myrmecia* is specialised in having M only two-branched, leaving R much more distad and almost at right-angles instead of at an acute angle, and in having rm_1 placed beneath the well-formed pterostigma. I have previously (Tillyard, 1926, p. 287, fig. T40) marked this cross-vein as rm_2, on the supposition that rm_1 had been eliminated, following Bradley's study of the EVANIIDAE (1908). But there are no EVANIIDAE or other ICHNEUMONOIDEA in which both rm_1 and rm_2 occur together; thus the whole of his phylogeny stands or falls on the weak point of his having derived the group from an ancestor whose venation resembled that of *Janus* in the CEPHIDAE. It does not follow that, because *Janus* has partially lost rm_1, therefore the EVANIIDAE have wholly lost it. On the present fossil evidence, it seems more probable that the cross-vein below the pterostigma is rm_1, and that rm_2 was never formed either in the ICHNEUMONOIDEA or in the FORMICOIDEA.

(6) *Reduced Parasitic Types*:—The Upper Jurassic fossil *Mesohelorus* provides the key to the manner in which the reduction of the venation of the PROCTOTRYPOIDEA has been effected. This genus had a complete pterostigma, with rm_1 at right-angles below it; M came off at right-angles from R well before the pterostigma; both branches of M (M_{1+2}, M_{3+4}) were complete to margin of wing; cells *1r* and *1m* were completely closed. Venationally, all types within the PROCTOTRYPOIDEA and BETHYLOIDEA can be logically derived from this by reduction-stages. The same argument can be applied to the CYNIPOIDEA and CHALCIDOIDEA, bearing in mind that they are specialised in other important directions. In many Cynipoids, both the basal piece of M and the cross-vein rm_1 remain as thickened veins, long after most of the main veins have disappeared. In the CHALCIDOIDEA it seems probable that even the basal piece of M has disappeared, leaving rm_1 as the thickened stigmatic vein when that is present.

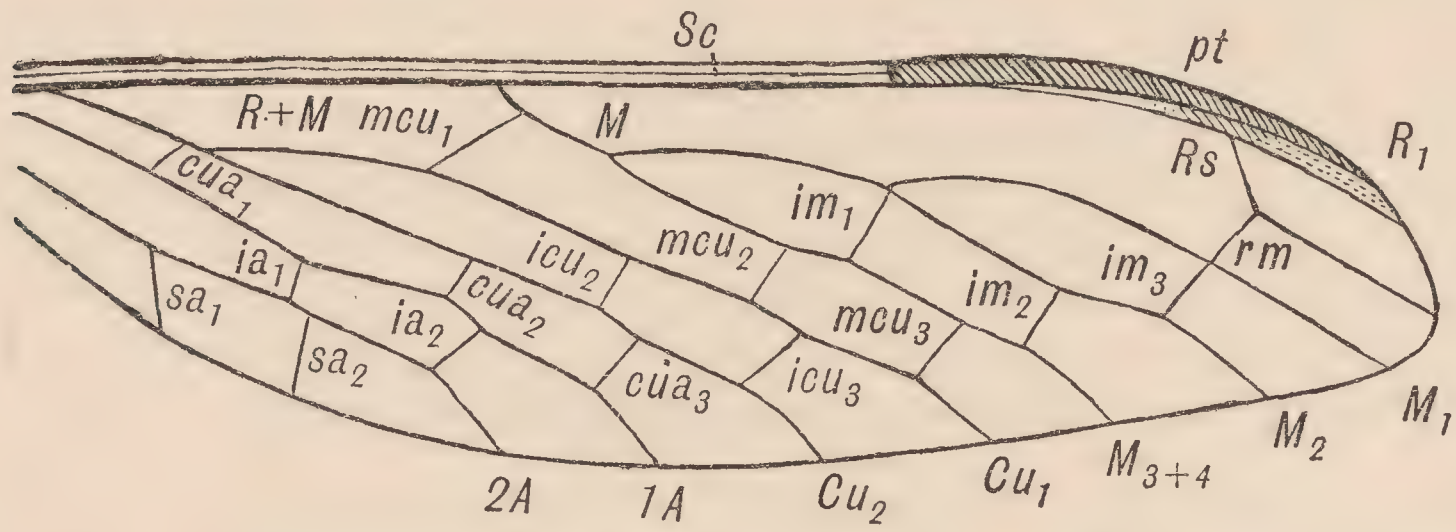
(7) *Vespoid and higher Types*:—It has always been difficult to conceive why these types, admittedly the highest in the Order, should have, on the whole, such complete venation. If, however, we now recognise the ancestral stage with only three closed cells in the wing as more archaic than those having five or six, we can understand this. For the oldest types of Clistogastra (ICHNEUMONOIDEA) may be conceived of as having left the main stem before the attainment of the five-celled condition, while the VESPOIDEA and higher groups must have diverged later on from more specialised types with more closed cells in the wing. It would seem that this took place just at the time when rm_2 was becoming stabilised beneath the strengthening pterostigma; and, almost at the same time, rm_1 began to degrade in these groups, probably because rm_2 was more advantageously placed near the middle of the pterostigma, and two supports were not really needed. Thus we can still find a remnant of rm_1 in the family THYNNIDAE; but in all other families it is entirely absent. So these higher groups may be said to start off with forms having five closed cells in the fore-wing, of which one represents cells *1r* and *2r* combined, this cell being still partially divided into two in the THYNNIDAE only. This cell may conveniently be designated *r*. There is a number of forms in all the higher groups in which the venation is reduced; but in no case does the reduction parallel the original three-celled condition found in *Pseudosirex*. Usually the two closed cells which are kept are *r* and *1sm*, while cells *1m* and *2m* first fuse together and move distad towards the apex, and finally disappear entirely, as, for instance, in *Trypoxylon*.

Origin of the Order Hymenoptera.

Having completed the account of the evidence available within the Order Hymenoptera itself, let us now examine the problem of the origin of that Order.

In 1924, I proposed the new Order Protohymenoptera for the reception of three remarkable genera discovered in the Lower Permian of Kansas, viz. *Protohymen* (text-fig. 5), *Permohymen* and *Asthenohymen*. These appear to me to be essentially Hymenopteroid in structure, but are not true Hymenoptera because they have fore- and hind-wings still closely similar in shape and venation, and there are no connecting hamuli between the two. As the bodies of these insects are not preserved sufficiently for study, their exact relationship to existing forms of Hymenoptera must remain still somewhat problematical. Owing to the extreme narrowness of the costal space in all three genera, it would be scarcely possible to derive the oldest Tenthredinoid or Siricoid types from them.

In studying the Upper Carboniferous fossils, I became interested in the apparently Hymenopteroid facies of the problematical *Sycopteron symmetricum*, Bolton, from the Commentry beds in France. Bolton suggested that this fossil



Text-fig. 5.—*Protohymen permianus*, Till., Lower Permian of Kansas. Venation of fore-wing. New Notation.

had affinity with the Mecoptera. But it was evident to me that this was not so, if only from the fact that the fossil showed a simple Rs. A study of the venation from Bolton's figure (1917, pl. ii, fig. 2) indicated some affinity between this fossil and the Protohymenoptera. I therefore promised myself that I would examine the fossil more minutely when opportunity offered. Fortunately the specimen is in the Manchester Museum; through the kindness of my friend Dr. G. H. Carpenter, Keeper of the Museum, I was enabled to study it fully during my recent visit to England.

The specimen is the smallest of all the Commentry fossils, the length of the fore-wing being only 9·4 mm. and the total length of the body about 12 mm. The head and thorax are complete, but the antennae, legs, abdomen and tips of the wings are missing. The wings are folded flatly down upon the abdomen, the fore-wings overlying the hind, so that only the barest traces of the venation of the latter can be made out. Almost certainly the venation of the hind-wing was similar to that of the fore, since there are traces of duplication of venation here and there on the right side.

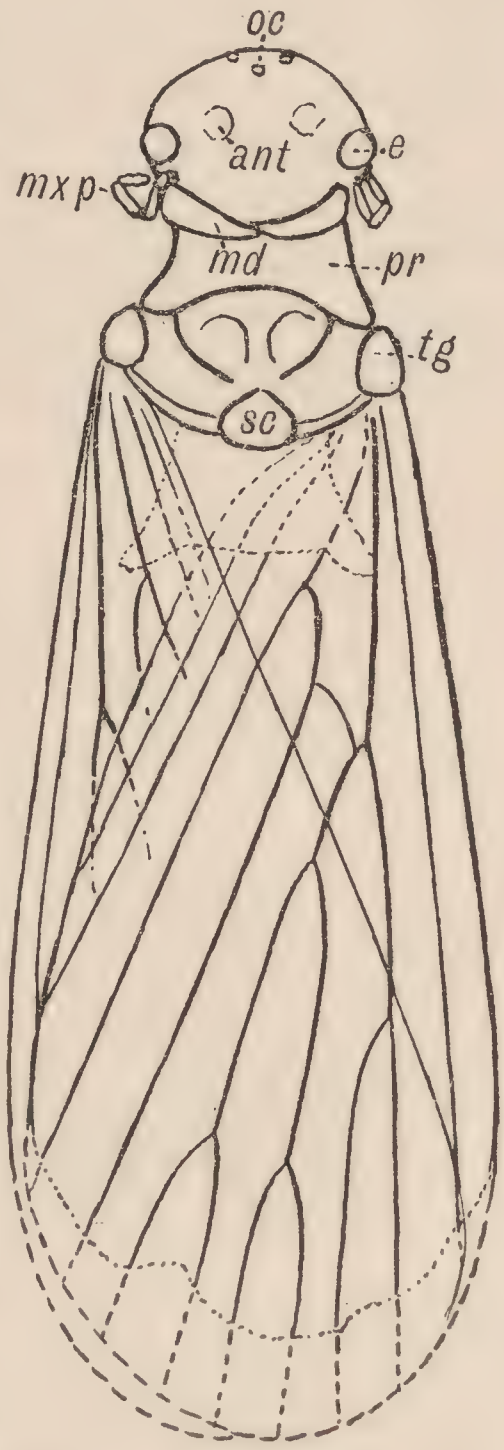
A comparison between text-fig. 6 and Plate XXVI should go far to convince us of the Hymenopteroid affinity of this fossil. The head was a hard, more or less rounded capsule, which made a deep impression in the rock. It became

fossilised in a depressed position, so that the three ocelli (*oc*), still just visible, come to lie on the anterior margin of the impression; the eyes (*e*) are small, rounded, placed at the sides of the head, but not projecting to any extent; the sockets of the antennae (*ant*) show plainly through from below, but the antennae themselves are, unfortunately, missing. The huge mandibles show up clearly in position (*md*) and appear to be of a closely similar type to those of *Sirex*. At their sides can be seen two small appendages which are almost certainly palpi (*mxp*); from their position, one would take them to be the maxillary palps, but only three segments can be made out.

Thus it will be seen that the head is definitely Hymenopteroid in form. But it is when we come to study the thorax that the most striking similarities are to be noted. For here we see clearly the pronotum of typical Siricoid form, broad and with the side-lobes extending back to the tegulae (*tg*), which are themselves also clearly marked. The mesoscutum is large and of Siricoid form, though it does not project forward quite as much as in *Sirex*; the scutellum (*sc*) is also strongly marked.

Coming to the wings (text-fig. 6), we note first of all the attachment just close to the tegula (*tg*), and the method of folding flatly down upon the abdomen. The presence of the tegula as a small, hard plate would indicate either Hymenopteroid or Fulgoroid affinities for this fossil. There is no difficulty in deciding between these two, owing to the shape of the head and thorax and the presence of the powerful mandibles. The method of folding the wings must have been a high specialisation in Carboniferous times, and is found there in only one other group, viz. the highly specialised and successful Cockroaches, which were then dominant.

As regards the venation, we are at once struck with the almost entire absence of cross-veins. The only one that can be made out with any certainty is mcu_1 (text-fig. 7) supporting M from below. On the right side, this cross-vein appears to be duplicated slightly distad, thus indicating that it was present also in the hind-wing. If any other cross-veins were present, they were too faint to be made out.

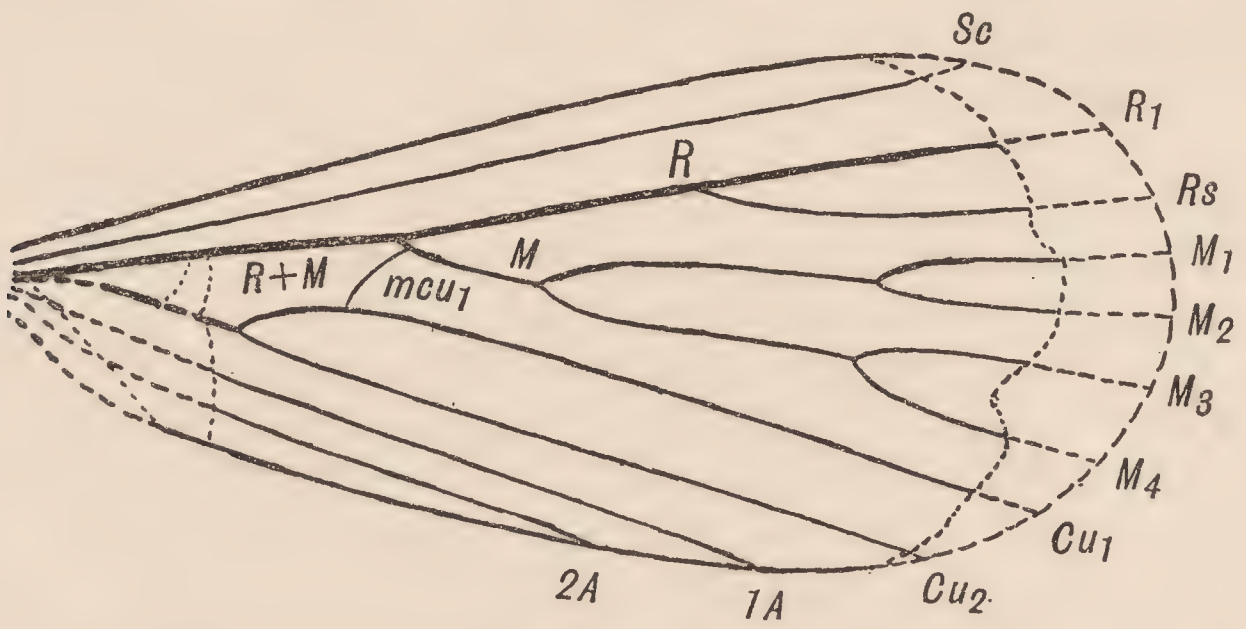


TEXT-FIG. 6.—*Sycopteron symmetricum*, Bolton, Upper Carboniferous of Commentry, France. Camera-lucida drawing of type. Total length about 12 mm. *ant*, antennal sockets; *e*, eye; *md*, mandibles; *mxp*, maxillary palp; *oc*, ocelli; *pr*, pronotum; *sc*, scutellum; *tg*, tegula.

As regards the main veins, Sc was a straight and simple vein, running almost parallel with the costa to near the apex of the wing. R was a strong vein diverging slightly from Sc and giving origin to M at about one-third of the wing-length, and then to Rs a little before two-thirds. *Rs is a simple vein;* contrast this with the many-branched condition of all Mecoptera from the Lower Permian to recent times! M is four-branched. Cu is two-branched, the fork occurring well before the cross-vein mcu_1, which passes obliquely from Cu_1 up to M close to its origin, and is therefore, perhaps, homologous with M_5 of the Mecoptera. There are two anal veins, 1A and 2A. All the veins are fairly straight and the branches more or less dichotomic.

We have now to compare this very primitive scheme of venation (text-fig. 7) with that of the PROTOHYMENIDAE and of various Hymenopterous types. Taking *Protohymen* (text-fig. 5) first, we note the marked difference in the shape of the wing, the narrowing of the costal space, the formation of an elongated pterostigma, the shifting of Rs distad to near the apex, the reduction of M to the three-branched condition, the addition of many cross-veins, and consequent slight zigzagging of some of the main veins. Points in common between the two wings are the position of M on R and the supporting vein mcu_1 below it, the simple Rs, the condition of the fork of Cu, and the presence of two anal veins. In no single character is *Protohymen* more primitive than *Sycopteron*, except in the possibly branched Rs.

When we come to compare existing Hymenopterous types of venation with *Sycopteron*, we are at once struck with the greater resemblance between such types and *Protohymen*, owing to the presence of cross-veins and consequent zigzagging of the main veins. We have, however, to ask ourselves whether such types as *Pseudosirex* (text-fig. 1), *Syntexis* (text-fig. 3) and *Macroxyela*



TEXT-FIG. 7.—*Sycopteron symmetricum*, Bolton, Upper Carboniferous of Commentry, France. Venation of fore-wing, with missing or indistinct portions restored by dotted lines. Length 9·4 mm. New Notation.

(text-fig. 4) can be more easily derived from *Protohymen* than from *Sycopteron*. At once we are met with the obvious difficulty of the narrowness of the costal space in *Protohymen*. This appears to preclude this genus, or any other of the known Lower Permian forms, from being the direct ancestor of the Order Hymenoptera. On the other hand, *Sycopteron* appears, if anything, to take us too far back. For our direct ancestor we need a form which, in the general structure of the head and thorax, resembled *Sycopteron*, but, in the wing-venation, was in advance of it in two points, viz. reduction of M to a three-branched condition through loss of the fork of M_{3+4}, and addition of a certain number of advantageously spaced cross-veins over and above mcu_1, with consequent slight zigzagging of some of the main veins.

A fair conclusion to arrive at would be, I think, that the Hymenoptera have been derived from such a form as that indicated above, and that *Sycopteron* is one of the Upper Carboniferous ancestors of that form. That being so, we may properly place *Sycopteron* within the extinct Order Protohymenoptera, in a new family SYCOPTERIDAE, which was even more primitive in the form of its venation than the immediate ancestor of the whole existing Order.

There is, in the fossil *Sycopteron*, a slight suggestion of a pointed abdomen projecting beyond the end of the wings; this can be seen in Bolton's plate ii, fig. 1. In the actual specimen, I could not decide whether this was part of the

actual impression made by the insect, or merely a chance depression in the rock. I have omitted it from my drawing in text-fig. 6. If, however, it really belongs to the specimen, it would indicate that it was a female, and possessed an ovipositor not unlike that of *Sirex* and *Pseudosirex*. Again I must draw attention to the extraordinary resemblances in resting position between the fossil *Sycopteron* (text-fig. 6) and the living *Sirex* (Plate XXVI).

We may now attempt a short definition and classification of the extinct Order Protohymenoptera :—

Insects with the head, thorax and abdomen closely similar to those of existing primitive Chalastrogastra, the tegulae well formed and the wings either folded back flatly above the abdomen (*Sycopteron*, *Asthenohymen*) or perhaps held out at right-angles to it (?*Protohymen*, *Permohymen*). Rs simple (possibly two-branched in *Protohymen*, but, if so, then R_{2+3} very close below R_1). M arising far along the main stem of R, and supported by a specialised cross-vein mcu_1 below it, close to its origin. (This character holds for the whole Hymenopteroid complex, and for no other insects.) M with either four or three branches. Cu two-branched, the fork close to the base. Only two anal veins. Fore- and hind-wings closely similar and without any connecting hamuli.

The two known families may then be distinguished as follows :—

1. M four-branched; no visible cross-veins except only mcu_1. Family Sycopteridae (Upper Carboniferous).
   M three-branched; extra cross-veins well developed, with consequent slight zigzagging of some of the main veins . . (Lower Permian forms) 2.
2. Pterostigma and Rs present . . . . . Family Protohymenidae.
   Pterostigma and Rs absent . . . . . Family Asthenohymenidae.

As regards the origin of the Order Protohymenoptera itself, it is impossible to speak with certainty. The presence of two anal veins prevents this Order from being derived from the Megasecoptera, though Handlirsch thinks that the Lower Permian forms stand close to or even within this Order. The large number of characters shared in common between Hymenoptera and Odonata, viz. general form of head, mobile neck, strong, glassy wing-membrane, complete ovipositor, numerous Malpighian tubules, might indicate a common origin far back in geologic time within the old Order Palaeodictyoptera; but these characters were probably shared at such a time with many other ancestral types of winged Insects. There is certainly much to suggest that the original ancestor of the Hymenoptera was a carnivorous or omnivorous type extinct long since; all the existing forms are highly specialised in one or other direction.

In conclusion, it seems evident that other types of fossil Protohymenoptera may be expected to turn up in Permian strata in various parts of the world, while the beginnings of the actual Order Hymenoptera should be looked for in the Triassic. No Hymenopteroid types have been found either in the Upper Permian or Upper Triassic of Australia, but this probably only indicates that the Order did not reach Australia until a considerably later date.

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Explanation of Plate XXVI.

Two *Sirex juvencus*, L. (left, ♀; right, ♂), alive on bark of young tree of *Pinus radiata*, to show position of rest and longitudinal ridges on distal half of fore-wings; note also the projecting ovipositor of ♀. From photo. taken by Mr. W. C. Davies at the Cawthron Institute, February, 1926.

Enlarged; actual total length, including ovipositor, of the female specimen to the left, 35 mm.

Postscript (added March 5th, 1927) :—

In this paper I have omitted to mention the fact that, nine years ago, I discussed the affinities of the fossil *Sycopteron symmetricum*, Bolton, in a paper entitled "On the Affinities of Two Interesting Fossil Insects from the Upper Carboniferous of Commentry, France" (*Proc. Linn. Soc. N.S.W.*, 1918, vol. xlii, pt. 1, pp. 123–134). The conclusion there arrived at, on the scanty evidence at that time available, and with only the published figures before me, was that this fossil could not possibly belong to the Order Mecoptera, but might quite possibly belong to the Order Copeognatha and be related to the archaic genus *Amphientomum*. At the time I wrote that paper, I had had in mind a possible connection between *Sycopteron* and the Hymenoptera, but I ruled this latter Order out as being far too highly specialised to have existed in the Carboniferous. With the discovery of the Protohymenoptera in the Lower Permian, the position becomes radically altered, and I had again to consider the possibility which I had previously ruled out. When I studied the fossil itself in London, I found that the structure of the head and thorax shows little resemblance to those of Copeognatha (as the published figures rather suggest) but are definitely Hymenopteroid. I have added this postscript in order to make it quite clear that the change in my opinion concerning this interesting fossil is entirely due to the new evidence now available.

W. C. Davies, photo. *Vaus & Crampton, Ltd.*

THE ANCESTRY OF THE HYMENOPTERA: SIREX JUVENCUS.

NOTES ON THE FEMALE GENITALIA IN THE MICROPTERYGOIDEA

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[Read October 5th, 1927.]

Plate XXVII.

Though a good deal of work has been done on the male genitalia of the Micropterygoidea, comparatively little attention has been paid to the generative organs of the female. In view of this the writer has thought it worth while to put together the following notes, admittedly very incomplete, on the female genitalia of the Eriocraniidae and Micropterygidae.

Eriocraniidae.

Eriocrania. (Figs. 1 to 7.)

The Micropterygoidea and some other groups of the more generalised Lepidoptera are distinguished by having a single genital opening in the female; that is to say, the ductus bursae, instead of opening ventrally on the eighth sternite, passes on to the end of the abdomen, where it either joins the oviduct or discharges separately into the commissure formed by the lobes of the terminal segment. Chapman's (1) proposal to form a new Order, Zeugloptera, on this character was intended to apply to the Micropterygidae (*sens. str.*) only, he being under the impression that the Eriocraniidae exhibited the double type of genital opening. This is not so, however; the Eriocraniidae agree with the Micropterygidae in possessing a single genital opening.

In the Eriocraniidae the abdomen of the female consists of nine segments. The terminal segment, however, is modified to form an exsertile ovipositor. Normally, only the tip of this organ projects beyond the eighth segment, but when drawn out it is seen to consist of a long pair of segmental rods, which approach and fuse with each other apically. Beneath the apices of each of these lies a lateral rod with a short thicker piece projecting obliquely downwards from its base. Beyond these oblique pieces is still another, but longer, pair of rather weakly chitinised rods. At about one-fourth from the tips of the segmental rods proper there is a short irregular process, which in some species is continued caudally as a short chitinised rod. All these parts are membranously connected and form a sheath which encloses the genital and anal canals.

The eighth segment forms a strongly chitinised band, the pleural region not being differentiated; the segmental rods are about half the length of those on the ninth. Dr. Chapman (1) has figured a segment between these two rod-bearing ones, but his ninth segment is, I believe, merely the conjunctiva, which is here extensive and normally invaginated to about half its length. If Chapman's ninth segment were to be accepted it would mean that we should have the rods arising from the eighth and tenth segments instead of the usual eighth and ninth, an arrangement, as far as I am aware, unique in the Lepidoptera. Both the tergal and sternal portions of the eighth segment are much narrowed and pointed apically, and both divide into divergent forks at their extremities, the tips of these forks being recurved and partly hidden when the terminal

segment is in its normal position. The object of this structure is probably to give strength, and at the same time flexibility, to the ovipositor. The conjunctiva between the eighth and ninth segments is curiously ridged and folded, and under high magnification this structure is seen to consist of numerous closely-toothed bands. Between the forks of the sternite these bands become obsolete, giving place to a plain transparent area. There is no opening on the eighth sternite in *E. semipurpurella*, Steph.; the whole surface is uniformly chitinised and the apparent vagina in Chapman's photograph of the species must be due to some fault in the preparation. Apart from this also, dissection shows that no duct connects with this supposed aperture.

Owing to the difficulty attendant upon the dissection of such small forms—a difficulty made greater by the transparency of some of the organs—I have not been able to satisfy myself as to several details, but I give some figures which show the bursa copulatrix and its appendages. In *E. semipurpurella* it will be seen that on the ductus bursae there is a complicated strongly chitinised structure. I can offer no suggestion as to its functions, but I should mention that a somewhat similar organ is present in *Sabatinca heighwayi*, Philp.; probably it is a generic character in *Eriocrania* as it was present in several other species examined by the writer. Just beyond this structure a duct arises which soon expands into a globular vesicle, thence continuing it becomes much dilated for some distance, after which it returns to its original size and shortly terminates. At about the origin of this duct the expansion into the bursa copulatrix commences, and further on the latter organ bears a complicated structure consisting of a short duct carrying anteriorly a curved elongate vesicle and posteriorly an irregularly dilated expansion which terminates in a moderately long filament. Beyond this the bursa copulatrix extends as an irregular but rather narrow neck, ending in a more dilated apical portion. I am unable to state which of the two appendages described above is the receptaculum seminis; nor am I able to describe the ovaries. The walls of the latter are evidently extremely thin, transparent and elastic; in a gravid female the greater part of the abdomen is filled with eggs, but it is only with the greatest difficulty that any containing membrane can be made out. In several preparations, however the common oviduct could be seen uniting with the ductus bursae a little posterior to the "valve." Apparently the fertilisation of the ovum takes place as it passes into the common vestibule; the rectum also appears to discharge into this cloaca.

Mnemonica. (Fig. 8.)

Mosher (2) states that in this genus there are two genital openings in the female pupa, "apparently located on the ventro-meson of the eighth and ninth abdominal segments." Dr. Mosher recognises ten segments, but the figures given do not necessarily bear out this interpretation and it is desirable that the matter should receive further study. It would not, of course, be anything unusual for a ten-segmented pupa to give rise to a nine-segmented imago, but if it should prove to be a fact that an imago with a single genital opening was preceded by a pupa with two it would be strong evidence that the double opening condition was the more primitive, a conclusion which gains some support from Tillyard's (3) discovery in the pupa of *Sabatinca* of what may have been a vestigial ventral gonopore. On the other hand, the presence in the Micropterygidae of ten well-defined abdominal segments in association with a single terminal gonopore would seem to point to that condition as the original one. Here, however, a great difficulty confronts us. That two openings should

gradually approach each other and finally merge into one, or one, in course of time, have its functions assumed by its fellow, does not offer any insuperable difficulty, but it is hard to understand how a single opening could develop into two, yet continue to function normally as the process was going on. Should the ova be fertilised, as appears to be the case in *Sabatinca*, as they pass from the oviduct into the common duct, we can conceive of the junction of the ducts moving caudally till it finally reached the common outlet, the next step being the development of a paired opening where the fertilisation of the ova could still be carried out. But as soon as the copulatory opening began to recede ventrally it would be necessary for a connection (the seminal duct) to be established immediately between the bursa copulatrix and the oviduct, an improbable happening, in respect of the suddenness.

Of *Mnemonica* my material has been scanty, but in the few forms which I have been able to examine the genitalia have been found closely to resemble *Eriocrania*. The eighth sternite in *M. unimaculella*, Zett. (fig. 8) has an entirely membranous area near its apex which, unless closely examined, might easily be mistaken for the copulatory opening.

Micropterygidae.

Sabatinca. (Figs. 11 to 18.)

In *Sabatinca* the abdomen consists of ten segments. The ninth is a simple annular sclerite, the pleura having become completely chitinised; the tenth takes the form of two lateral hairy lobes, forming a commissure for the reception of the anal and genital openings. The segmental rods are not present. A single genital opening leads into the canal of the bursa copulatrix, which is a long pouch occupying more than half the length of the abdomen. The ductus bursae is rather stout, but usually well marked off from the bursa copulatrix. Just before the beginning of this latter organ there is, on the duct, a protuberant part from which arises what is apparently the receptaculum seminis. Usually this is a filament-like structure, but in some species, as *S. heighwayi*, Philp., and *S. eodora*, Meyr. (figs. 16, 17), it is a shorter and thicker organ, which, near its apex, is contracted, expanding again into a small bladder-like structure and ending in a short filament. These two forms also exhibit an extraordinary kind of armature on the bursa copulatrix. Surrounding the middle of the organ are four fork-like structures, the prongs being thickly clothed with spines. The "handles" are very short, strongly dilated and directed caudally. No other species of *Sabatinca* examined showed any trace of such armature, but a similar structure was found to be present in *Epimartyria pardella*, Wlshm. (fig. 9). The ovaries are a pair of very irregular elongate vessels and the oviduct joins the ductus bursae a short distance before its outlet.

I am able to give a figure of *S. ianthina*, Philp., in cop. (fig. 11). It will be seen that the tenth segment of the female is to a great extent withdrawn within the ninth, and that the tegumen of the male does not come into contact with the dorsal surface of the ninth tergite of the female. The juxta, though larger in this species than is usual for the genus, does not appear to possess any functional value as a support for the aedeagus.

Epimartyria. (Fig. 9.)

Of this genus my material has been very scanty and I am only able to show a figure of one rather unsatisfactory preparation. It will be seen that the bladder-like bursa copulatrix bears a similar armature to that present in certain

species of *Sabatinca* referred to above. The receptaculum seminis is also somewhat similar to the same organ in these species in that it is provided with a bulbous expansion midway of its length. The ninth segment appears to be divided ventrally and to be armed along the caudal margins with a series of sensory hairs. The terminal segment is not of the ordinary Micropterygid type, but seems to be a development towards that of the ERIOCRANIIDAE. Further material of this interesting genus is required in order to prepare a fuller and more definite description and the writer would be greatly obliged to anyone who would supply it.

Micropteryx. (Fig. 10.)

The female genitalia of *Micropteryx* differs little from the same set of organs in *Sabatinca*. I have not succeeded in tracing the actual junction of the oviduct and bursa copulatrix, but it must be close to the commissure of the tenth segment; or perhaps the two ducts discharge beside each other in this commissure. I am much indebted to M. Le Cerf, of Paris, who, among much other valuable material, sent me a pair of *M. calthella*, L., taken in copulation. From the figure drawn from this pair it will be observed that the uncus does not, as might be expected, lie along the dorsal surface of the female abdomen. It is prevented from doing so by projecting lateral plates (surgonopods) of the tegumen. These structures are armed apically with a row of minute hooked spines and the opening between them is closed above by a concave pleated chitinous piece arising from the base of the uncus, apparently a development of the closing membrane. The function of the surgonopods and the chitinous plate seems to be to fit round the dorsal portion of the tenth segment of the female and thus secure rigidity of the parts, assistance towards this end being given by the harpes which obliquely embrace the ninth segment from beneath.

In conclusion I wish to express my grateful thanks to Mr. O. W. Richards of Oxford, to M. Le Cerf of Paris and to Dr. Martin Hering of Berlin, who, by kind gifts and exchanges, have enabled me to carry out the investigation to the present stage.

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FEMALE GENITALIA IN THE MICROPTERYGOIDEA.

Explanation of Plate XXVII.

Fig. 1. *Eriocrania semipurpurella*, Steph. Dorsal view of apex of abdomen with genitalia attached.
2. *Eriocrania semipurpurella*, Steph. Lateral view of abdomen, 6th to 9th segments.
3. *Eriocrania semipurpurella*, Steph. Dorsal view of 8th and 9th segments.
4. ,, ,, Steph. Dorsal view of 9th and apical part of 8th segments.
5. *Eriocrania semipurpurella*, Steph. Lateral view of 9th segment.
6. ,, ,, Steph. Ventral view of apex of 8th sternite.
7. ,, ,, Steph. Ventral view of apex of 8th sternite, more highly magnified, to show area of supposed copulatory opening.
8. *Mnemonica unimaculella*, Zett. Ventral view of 8th sternite, to show supposed copulatory opening.
9. *Epimartyria pardella*, Wlshm. Ventral view of end of abdomen.
10. *Micropteryx calthella*, L. In copula.
11. *Sabatinca ianthina*, Philp. In copula.
12. ,, *aurantiaca*, Philp. Female genitalia.
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14. ,, ,, Huds. Area of union of oviduct with ductus bursae.
15. ,, *incongruella*, Walk. Female genitalia.
16. ,, *eodora*, Meyr. Female genitalia.
17. ,, *heighwayi*, Philp. Female genitalia.
18. ,, ,, Philp. Ventral view of strongly chitinised structure on ductus bursae.

Lettering.

ae, aedeagus; *bc*, bursa copulatrix; *c*, colon; *cd*, common duct of ovaries and bursa copulatrix; *cl*, cloaca; *cp*, chitinous plate between surgonopods; *db*, ductus bursae; *h*, harpe; *im*, intersegmental membrane (conjunctiva); *ov*, oviduct; *sg*, surgonopod; *sp*, spermatheca; *sr*, segmental rods; *teg*, tegumen; *to*, "trident" or "fork" organs; *u*, uncus; *vin*, vinculum; 8, 9, 10 = 8th, 9th and 10th segments; 8^s, 8th sternite; 8^t, 8th tergite.

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ERRATA

p. **8**, **3** lines from end for "*Parnasa*" read "*Parnara*."
p. **6**, line **18** for "*E. ariadne*" read "*A. ariadne*."
p. **6**, „ **50** „ "*missipus*" „ "*misippus*."
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p. **152**, „ **31** „ "*Blatella*" „ "*Blattella*."

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